ROSH

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SEARCH REQUEST FORM

Scientific and Technical Information Center

Requester's Full Name: Michael Ambrino Examiner #: 74902 Date: 12/29/06

Art Unit: 3736 Phone Number ~~30~~ X-24723 Serial Number: 10/525,747

Mail Box and Bldg/Room Location: RND-7A39 Results Format Preferred (circle): ~~PAPER~~ DISK E-MAIL

If more than one search is submitted, please prioritize searches in order of need.

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Please provide a detailed statement of the search topic, and describe as specifically as possible the subject matter to be searched. Include the elected species or structures, keywords, synonyms, acronyms, and registry numbers, and combine with the concept or utility of the invention. Define any terms that may have a special meaning. Give examples or relevant citations, authors, etc, if known. Please attach a copy of the cover sheet, pertinent claims, and abstract.

Title of Invention: _____

Inventors (please provide full names): See Attached

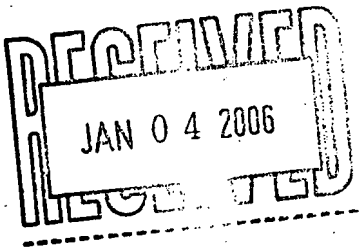
Earliest Priority Filing Date: _____

For Sequence Searches Only *Please include all pertinent information (parent, child, divisional, or issued patent numbers) along with the appropriate serial number.*

See claim (1+9) and 5

A61B/ 831
505

See also figs 1+4.



2006/74321

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DAINIPPON PHARM - SUMITOMO

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S1       1208   S ELECTROPHYSIOLOG?
S2      85160   S (BODY OR BIOLOGIC? OR VITAL OR PHYSIOLOGIC? OR MEDICAL? OR PATIENT? OR
OUTPATIENT? OR INPATIENT?)(2N)(SIGN? ? OR SIGNAL? OR OUTPUT? OR DATA? OR READING? OR
REPORT? OR INPUT?)
S3          4   S VPC(3N)(VENTRICUL? OR PREMATUR? OR CONTRACTION?) OR
VENTRICUL?()PREMATUR?()CONTRACTION?
S4     557728   S HR(3N)(HEART OR RATE?) OR HEART()RATE? OR PULSE? OR (QT OR QWAVE? OR
TWAVE? OR Q()WAVE? OR T()WAVE?)()INTERVAL?
S5       9314   S SPO2()VALUE? OR OXYGEN()(SATURAT? OR VALUE? OR LEVEL? OR PARAMETER?) OR
BLOOD()(GAS OR GASES OR GASSES) OR ELECTROCARD?
S6      18329   S HRV(3N)(HEART OR RATE OR VARIABILITY) OR SYSTOLIC? OR DIASTOL? OR (BLOOD
OR ARTER?)()PRESSUR?
S7       2708   S WAVEFORM()(INDEX? OR INDICE?) OR OXIMET? OR PLESTHYM? OR (BREATH? OR
RESPIRAT?)()RATE?
S8     660339   S S1:S7
S9       1295   S (DISPLAY? OR GRAPHIC? OR VISUAL?)()(OBJECT? OR SIGNAL? OR INDICATOR?) OR
ICON? ?
S10     63940   S INDICATOR? OR GRAPH? ? OR CHART? ? OR DIAGRAM?
S11     93771   S INSIGNIA OR REPRESENTATION? ? OR PICTORIAL OR DRAWING? ?
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S13       152   S AVATAR? OR EMOTICON? OR FIGURINE? OR SMALL(2N)(IMAGE? OR GRAPHIC? OR
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S14      1587   S (SCREEN? OR ELECTRONIC?)(2N)(REPRESENTATION? OR PICTUR? OR PICTOR? OR
IMAGE? OR SYMBOL? OR FIGURE?) OR SPRITE?
S15       201   S GRAPHICOBJECT? OR WIZARD? OR PIXIE? OR JINI? OR GENIE? OR TUTORIAL?
S16      1407   S (VIRTUAL? OR ANTHROPOMORPH? OR CARTOON? OR TOON? ? OR ANIMAT? OR
GRAPHIC? OR VISUAL?)(3N)(CHARACTER? OR CREATUR? OR ENTIT? OR ASSISTANT? OR SYMBOL? OR
REPRESENTATION? OR AGENT? OR INTERFACE?)
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S18      6423   S CONCAV? OR CONVEX? OR ROUND? OR (DISH OR DISK OR DISC OR PLATE? OR
SAUCER?)()SHAPE?
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DISCSHAP? OR DISKSHAP? OR DISHSHAP?
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TIMEDAT?
S22      1458   S TIME()(STAMP? OR DATE? OR SERIE?)
S23     73251   S PRIOR? OR BEFORE? OR EARLIER OR PREVIOUS?? OR ADVANCE OR PRECED??? OR
PRECEED??? OR AHEAD
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RECORD? ? OR CHRONICLE? ? OR ANNALS
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S27     76454   S IC=(A61B? OR G06F?)
S28     38766   S MC=(P31? OR S05?)
S29     53277   S S8 AND S9:S16 AND S17:S26
S30     15247   S S29 AND S27:S28
S31     53277   S S29:S30
S32      4072   S S31 AND S17:S20 AND S21:S26
S33        77   S S32 AND S9:S16(5N)S17:S20 AND S1:S7(7N)S21:S26
S34        88   S S32 AND S9:S16(7N)S17:S20 AND S1:S7(7N)S21:S26
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S36        22   S S35 AND S21:S26(7N)S17:S20
S37        88   S S35:S36
S38        41   S S37 AND AC=US/PR
S39        35   S S38 AND AY=(1970:2003)/PR
S40        31   S S38 NOT AY=(2004:2007)/PR
S41        47   S S37 NOT S38
S42        42   S S41 AND AY=1970:2003
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S43         39   S S41 NOT AY=2004:2007
S44         80   S S39:S40 OR S42:S43
S45         80   IDPAT (sorted in duplicate/non-duplicate order)
S46         79   IDPAT (primary/non-duplicate records only)
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[File 347] **JAPIO** Dec 1976-2006/Sep(Updated 061230)

[File 350] **Derwent WPIX** 1963-2006/UD=200705

**File 350: DWPI has been enhanced to extend content and functionality of the database. For more info, visit http://www.dialog.com/dwpi/.*

46/7/41 (Item 41 from file: 350) **Links**
Derwent WPIX

0010143297 *Drawing available*
WPI Acc no: 2000-451744/
XRPX Acc No: N2000-336372
Operational measurement of a periodically-changing system for establishing performance scale to determine functionality of system, such as cardio-circulatory system, to diagnose myocardial fitness
Patent Assignee: KUNIG H E (KUNI-I); KUNIG S V (KUNI-I)
Inventor: KUNIG H E; KUNIG S V

Patent Family (2 patents, 20 countries)

Patent Number	Kind	Date	Application Number	Kind	Date	Update	Type
WO 2000032103	A1	20000608	WO 1998US25397	A	19981130	200039	B
EP 1135057	A1	20010926	EP 1998961837	A	19981130	200157	E
			WO 1998US25397	A	19981130		

Priority Applications (no., kind, date): WO 1998US25397 A 19981130

Patent Details

Patent Number	Kind	Lan	Pgs	Draw	Filing Notes	
WO 2000032103	A1	EN	32	6		
National Designated States,Original	CA JP					
Regional Designated States,Original	AT BE CH CY DE DK ES FI FR GB GR IE IT LU MC NL PT SE					
EP 1135057	A1	EN			PCT Application	WO 1998US25397
					Based on OPI patent	WO 2000032103
Regional Designated States,Original	DE FR					

Alerting Abstract WO A1
NOVELTY - The device includes combination of sensors responsive to electromechanical physiological parameters (EPP), device to transmit the EPP to a computer for computing the magnitudes at various times, difference in magnitudes at various times ratio of change relative to initial values and time trend of computed parameters. Computer further includes sensors responsive to pre-selected magnitudes of EPP to serve as base unit on performance scale.
USE - For measuring patient's health performance by developing performance scales for cardio-circulatory parameters, and displaying patient's operational functionality on performance diagrams.
ADVANTAGE - Measures objectively and quantitatively human performance by developing cardio-circulatory performance scale, identifying basal units of haemodynamic parameters for display, to determine critical zones affecting life, myocardial fitness, etc. Enables determination of operational functionality of a patient's

cardio-circulatory system, in order to generate performance diagrams/scales; highlights critical zones, enabling diagnosis of myocardial fitness etc., with any trends towards possible cardio-circulatory failure being indicated. Method enables design/monitoring of therapies for different treatments of forms of myocardial impairment, deficiency, rehabilitation, conditioning exercises, etc. Efficacy of drug medications may be evaluated, and general predictions made of the likely results of different treatments.

DESCRIPTION OF DRAWINGS - The drawing shows a block diagram of apparatus used in the inventive system.

1 Subject patient
2 Measurement parameter sensors
9 Monitoring apparatus
11 Visual alarms
12 Indicator
15 Modem for data transmission over telephone line to central storage location
17 Memory in
4 Computer for storing all information/data

Title Terms /Index Terms/Additional Words: OPERATE; MEASURE; PERIOD; CHANGE; SYSTEM; ESTABLISH; PERFORMANCE; SCALE; DETERMINE; FUNCTION; CARDIO; CIRCULATE; DIAGNOSE; MYOCARDIUM; FIT

Class Codes

International Patent Classification

IPC	Class Level	Scope	Position	Status	Version Date
A61B-005/02			Main		"Version 7"

File Segment: EngPI; EPI;
DWPI Class: S05; P31
Manual Codes (EPI/S-X): **S05-D01A1**; **S05-D01B**

Original Publication Data by Authority

EPO

Publication No. EP 1135057 A1 (Update 200157 E)
Publication Date: 20010926
METHODE UND GERAT ZUR FUNKTIONALITATSMESSUNG EINES PERIODISCH VERANDERNDEN SYSTEMS
METHOD AND APPARATUS FOR MEASURING FUNCTIONALITY OF A PERIODICALLY CHANGING SYSTEM
PROCEDE ET DISPOSITIF SERVANT A MESURER LA FONCTIONNALITE D'UN SYSTEME A MODIFICATION PERIODIQUE
Assignee: Kunig, Sabine Vivian, P.O. Box 192, Saltsburg, PA 15681, US (KUNI-I)
KUNIG, Horst, E, P.O.Box 192, Saltsburg, PA 15681, US (KUNI-I)
Inventor: Kunig, Sabine Vivian, P.O. Box 192, Saltsburg, PA 15681, US

KUNIG, Horst, E, P.O.Box 192, Saltsburg, PA 15681, US
Agent: Helling, Siegfried, Ziolkowskistrasse 43, 09599 Freiberg, DE
Language: EN
Application: EP 1998961837 A 19981130 (Local application)
WO 1998US25397 A 19981130 (PCT Application)
Related Publication: WO 2000032103 A (Based on OPI patent)
Designated States: (Regional Original) DE FR
Original IPC: A61B-5/02(A)
Current IPC: A61B-5/02(A)
Original Abstract: A diagnostic, and monitoring device (4) is disclosed to determine functionality of the cardio-circulatory system, generate performance diagrams, and to measure cardio-circulatory functionality on the performance scale. The diagnostic monitoring device further identifies zones of criticalities on the performance scale used as reference to diagnose myocardial fitness, myocardial impairment, hyper, hypo-systolic dysfunctional, hypo-diastolic dysfunctional, dysfunctional pre-loads, after loads, critical illness, the trends to diagnose cardio-circulatory compliance, failure, outcome, and fitness. The method, and device have utility to design, monitor therapies for differential treatment of myocardial impairment, dysfunctions, rehabilitation, conditioning exercises, evaluate the efficacy of drugs, and to predict outcome of interventions.

WIPO

Publication No. WO 2000032103 A1 (Update 200039 B)
Publication Date: 20000608
METHOD AND APPARATUS FOR MEASURING FUNCTIONALITY OF A PERIODICALLY CHANGING SYSTEM
PROCEDE ET DISPOSITIF SERVANT A MESURER LA FONCTIONNALITE D'UN SYSTEME A MODIFICATION PERIODIQUE
Assignee: KUNIG, Sabine, Vivian, P.O Box 192, Saltsburg, PA 15681, US Residence: US Nationality: US (KUNI-I)
Inventor: KUNIG, Sabine, Vivian, P.O Box 192, Saltsburg, PA 15681, US Residence: US Nationality: US
Agent: KUNIG, Horst, E., P.O. Box 192, Saltsburg, PA 15681, US
Language: EN (32 pages, 6 drawings)
Application: WO 1998US25397 A 19981130 (Local application)
Designated States: (National Original) CA JP
(Regional Original) AT BE CH CY DE DK ES FI FR GB GR IE IT LU MC NL PT SE
Original IPC: A61B-5/02(A)
Current IPC: A61B-5/02(A)
Original Abstract: A diagnostic, and monitoring device (4) is disclosed to determine functionality of the cardio-circulatory system, generate performance diagrams, and to measure cardio-circulatory functionality on the performance scale. The diagnostic monitoring device further identifies zones of criticalities on the performance scale used as reference to diagnose myocardial fitness, myocardial impairment, hyper, hypo-systolic dysfunctional, hypo-diastolic dysfunctional, dysfunctional pre-loads, after loads, critical illness, the trends to diagnose cardio-circulatory compliance, failure, outcome, and fitness. The method, and device have utility to design, monitor therapies for differential treatment of myocardial impairment, dysfunctions, rehabilitation, conditioning exercises, evaluate the efficacy of drugs, and to predict outcome of interventions.

PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : A61B 5/02	A1	(11) International Publication Number: WO 00/32103
		(43) International Publication Date: 8 June 2000 (08.06.00)

(21) International Application Number: PCT/US98/25397

(22) International Filing Date: 30 November 1998 (30.11.98)

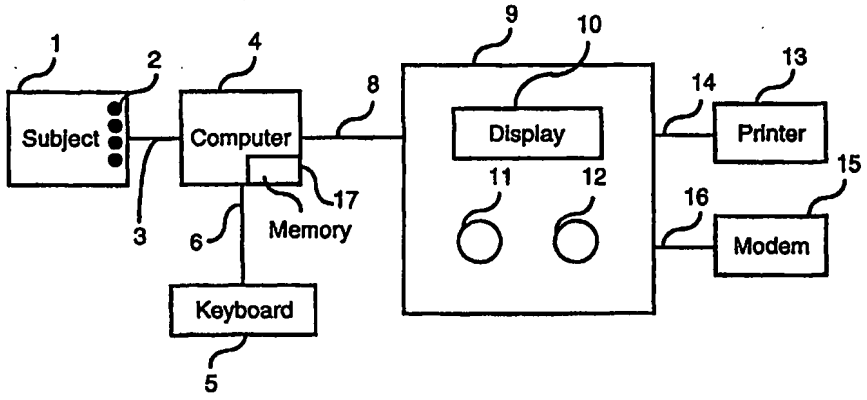
(71)(72) Applicant and Inventor: KUNIG, Sabine, Vivian [US/US]; P.O Box 192, Saltsburg, PA 15681 (US).

(74) Agent: KUNIG, Horst, E.; P.O. Box 192, Saltsburg, PA 15681 (US).

(81) Designated States: CA, JP, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.

(54) Title: METHOD AND APPARATUS FOR MEASURING FUNCTIONALITY OF A PERIODICALLY CHANGING SYSTEM



(57) Abstract

A diagnostic, and monitoring device (4) is disclosed to determine functionality of the cardio–circulatory system, generate performance diagrams, and to measure cardio–circulatory functionality on the performance scale. The diagnostic monitoring device further identifies zones of criticalities on the performance scale used as reference to diagnose myocardial fitness, myocardial impairment, hyper, hypo–systolic dysfunctional, hypo–diastolic dysfunctional, dysfunctional pre–loads, after loads, critical illness, the trends to diagnose cardio–circulatory compliance, failure, outcome, and fitness. The method, and device have utility to design, monitor therapies for differential treatment of myocardial impairment, dysfunctions, rehabilitation, conditioning exercises, evaluate the efficacy of drugs, and to predict outcome of interventions.

other. All measurements are afflicted with an unavoidable error. The true value of the measurement is never known only that it falls within the error range. For two measurements to be truly different the error ranges cannot overlap otherwise both measurements may fall into the overlap region where they would not be different from each other.

The embodiment, as shown in FIG. 3 illustrates the teachings of the instant. Accordingly, sensors 2 are placed on a subject 1 to detect signals representative of electromechanical physiological signals A to include but not limited to ventricular and atrial volumes, cross-sectional ventricular and atrial areas, ventricular, arterial, central venous, jugular, radial, pulmonary artery, carotid, and atrial pressures, electrical signals, echocardiographic signals, time signals for one heart cycle, and heart rate which are transmitted on multi-line wire 3 to computer 4. Such sensors 2 may include catheters, ultra-sound equipment, pressure transducers, blood pressure cuffs, electrodes, and echocardiographic sensors as required for differential assessment of the left or right heart electromechanical physiological parameters. Additional input representative of patient information including weight, height, body surface area, pre-selected time intervals, and pre-selected basal electromechanical physiological parameters values is provided from a keyboard 5 to computer 4 on line 6. Computer 4 is programmed to process the incoming signals on

line 6 to establish a basal value for AA^*_{basal} as basal unit for the cardiocirculatory functionality scale and to establish basal values $EF(A)_{basal}$, $A_1{}^*_{basal}$, and $A_2{}^*_{basal}$ for further establishing boundary zones of criticality. Computer 4 is also programmed to process the incoming signals on line 3, to determine their magnitudes and to convert them into multiples of the basal unit for use on the cardiocirculatory performance scale. Further, computer 4 generates a performance diagram, establishes zones of criticality and determines myocardial impairment, myocardial fitness, hyper- and hypo- systolic and diastolic dysfunctionality, and critical illness by reference to the zones of criticality. Additionally, computer 4 determines suitable values of EF(A), AA^*, A_1^*, and A_2^* to establish a trend for diagnosis of compliance and failure of the cardiocirculatory system. All parameters, representative of said functionality, are transmitted by line 8 to a monitor 9 which is comprised of a display 10, audible and visual alarms 11 to warn of emergencies if preset values of the parameters are attained, and indicators 12 to display diagnosis of myocardial impairment, hyper- and hypo- dysfunctionality, critical illness, compliance, failure, progress, regress, outcome, and physical fitness from the attainment of specific magnitudes of the electromechanical physiological variables, measured on the cardiocirculatory performance scale by reference to the zones of criticalities. The signals displayed by display 10 and the audio and visual alarms 11

and the signals displayed by indicator 12 are transmitted on line 14 to a printer 13 for producing hard copies and on line 16 to a modem 15 for transmission over telephone lines to central storage. A memory 17 in the computer 4 serves as storage of all information and data.

Referring now to FIG. 4, there is shown a PD generated by computer 4 of FIG. 3 from data published by Bonignore et.al. in an article entitled, *Obstructive sleep apneas*, in Respiratory Critical Care Medicine 1994;149:155-159, prior to, during and after termination of a sleep apnea. Here the electromechanical physiological parameter AA* is the pulmonary artery pulse pressure, PP*, A_1* is the systolic pulmonary artery pressure SBP*, and A_2* is the diastolic pulmonary artery pressure, DBP* all measured in basal units and displayed versus time at successive heart beats, according to the instant invention, said PD showing alternating hyper-dysfunctionality, H, myocardial impairment, M, systolic hypo-dysfunctionality, S, diastolic hypo-dysfunctionality, D, and critical illness, C, during the apneic period. According to the instant invention, an alarm is triggered upon the attainment of the danger zones of myocardial impairment and hypo-dysfunctionality. A different sound may be triggered upon the attainment of the zone of critical illness, thus, providing an instant warning of imminent death.

Referring now to FIG. 5, there is shown a PD generated by

CLAIMS

I claim:

1. A cardiac diagnostic device and method for establishing cardiocirculatory functionality of an individual, said device including the combination of:

means for measuring physiological parameters of such subject;

means responsive to the measurement of physiological parameters for deriving cardiocirculatory functionality;

means for deriving a cardiocirculatory performance scale;

means for measuring cardiocirculatory functionality on the performance scale;

means for establishing zones of criticality on the performance scale;

means for display of cardiocirculatory functionality in a performance diagram;

means to diagnose normo-functionality, hyper-dysfunctionality, myocardial fitness, myocardial impairment, hypo-dysfunctionality, and critical illness on the cardiocirculatory performance scale by reference to the zones of criticality; and

means to diagnose cardiocirculatory compliance and failure from trend measurements to determine outcome.

2. The cardiac diagnostic device according to claim 1 wherein said measurements of physiological parameters include any and all electromechanical physiological parameters;

3. The cardiac diagnostic device according to claim 1 wherein said means for deriving said cardiocirculatory performance scale includes a computer for establishing basal units, for said cardiocirculatory performance scale from inputs of multiples of constant physiological parameters via a keyboard, said basal units further establishing zones of criticalities.

4. The cardiac diagnostic device according to claim 1 wherein said means for establishing cardiocirculatory functionality includes a computer for determining cardiocirculatory functionality from the functionality equations

$$AA^* = EF(A) * A_1^*$$

$$AA^* = A_1^* - A_2^*$$

$$EF(A) = A_1 - A_2$$

wherein AA^*, A_1^*, and A_2^* equal AA, A_1, and A_2 referenced to time, body surface area and basal AA^* and wherein A_1 is an electromechanical parameter measured at time t_1, A_2 is an electromechanical parameter measured at time t_2, and AA is the difference of A_1 and A_2.

5. The cardiac diagnostic device according to claim 4 wherein said computer measures cardiocirculatory functionality on the performance scale in multiples of basal units for display in

a performance diagram, and further establishes a trend of said functionality.

6. The cardiac diagnostic device according to claim 5 wherein said computer diagnoses myocardial fitness, myocardial impairment, hyper-systolic, hyper-diastolic, hypo-systolic, hypo-diastolic dysfunctionality, normo-functionality, preload, afterload, critical illness, cardiocirculatory compliance, and failure by comparison of EF(A), AA*, A_1*, A_2*, with the zones of criticalities and their time trend;

wherein EF(A) greater than the basal value establishes the zone of myocardial fitness;

wherein EF(A) less than the basal value establishes the zone of myocardial impairment;

wherein A_1* greater than the basal value establishes the zone of hyper-systolic dysfunctionality, excessive preloads and compliance;

wherein A_1* less than the basal value establishes the zone of hypo-systolic dysfunctionality, depressed preloads and failure;

wherein A_2* greater than the basal value establishes the zone of hyper-diastolic functionality, excessive afterloads, and compliance;

wherein A_2* less than the basal value establishes the zone of hypo-diastolic dysfunctionality, depressed afterloads,

and failure;

wherein AA* less than the basal value establishes a zone of critical illness;

wherein A_1*, AA*, and A_2* equal to their respective basal values establishes normo-functionality;

wherein trends of EF(A), A_1*, AA*, and A_2* approaching basal values denotes progress;

wherein trends of EF(A), A_1*, AA*, and A_2* departing from the basal values denotes failure;

7. The cardiac diagnostic device according to claim 3 wherein said computer is programmed to subject the measurements of all physiological measurements A and their derivatives to the test of separation, according to the relationship

$$|m_1 - m_2| > e\, m_1 + e\, m_2$$

to establish trends for progress and regress determinations.

8. The cardiac diagnostic device according to claim 6 to design and monitor patient-specific therapies for improvement of myocardial fitness and treatment of myocardial impairment, for treatment of hyper- and hypo- systolic and diastolic dysfunctionality, hypo- and hyper- preloads and afterloads, critical illness, for maintenance of cardiocirculatory compliance, and effectuating cardiocirculatory failure.

9. The cardiac diagnostic device according to claim 6 to diagnose cardiocirculatory fitness and to design and monitor

patient-specific rehabilitation and subject-specific conditioning programs.

10. The cardiac diagnostic device of claim 6 wherein said computer evaluates the efficacy of drugs to effectuate patients in the zones of criticalities and cardiocirculatory failure.

11. The cardiac diagnostic device of claim 1 wherein said sensors include catheters, pressure transducers, pressure cuffs, electrodes, or echocardiographic sensors.

12. The cardiac diagnostic device according to claim 1 wherein said measurements derived by said sensors correspond to any electromechanical physiological parameter, including ventricular volumes; ventricular and atrial cross-sectional areas; ventricular, arterial, central venous, pulmonary artery, wedge, carotid, atrial, jugular, and radial pressures, inspired and expired volume of gases, electrocardiographic and echocardiographic signals, time for completion of one heart beat, heart rate, pre-selected times, and combinations thereof.

13. The cardiac diagnostic device according to claim 1 for determining outcome by reference to functionality, cardiocirculatory compliance and cardiocirculatory failure.

14. A method of diagnosing cardiac functionality of an individual, said method including the steps of:

measuring electromechanical physiological parameters A

of said individual at an initial time t_1, denoted A_1, and at a subsequent time t_2, denoted A_2,

establishing a cardiocirculatory performance scale and further establishing basal units of said performance scale by referencing basal constant data of A to a pre-selected basal time of one heart beat and body surface area,

establishing zones of criticalities on the cardiocirculatory performance scale by reference to the basal units of said scale,

establishing cardiocirculatory functionality from functionality equations

$$AA^* = EF(A) * A_1$$

$$AA^* = A_1^* - A_2^*$$

$$EF(A) = (A_1 - A_2) / A_1$$

wherein AA^*, A_1^*, and A_2^* equal AA, A_1, and A_2 referenced to time body surface area, and basal AA^* and wherein A_1, is an electromechanical parameter measured at time t_1, A_2 is an electromechanical parameter measured at time t_2, and AA is the difference of A_1 and A_2.

establishing trends for the parameters computed by the functionality equations for display in a performance diagram;

subjecting the measurements of all physiological parameters and their derivations to the test of separation according to the relationship

$|m_1 - m_2| > e\ m_1 + e\ m_2$;

measuring electromechanical physiological signals on the cardiocirculatory performance scale by referencing the measured signals with respect to time, body surface area and the basal units;

diagnosing normo-functionality, myocardial fitness, myocardial impairment, hyper-systolic dysfunctionality, hyper-diastolic dysfunctionality, hypo-systolic dysfunctionality, hypo-diastolic dysfunctionality, preload, afterload, and critical illness by reference to the zones of criticalities, and diagnosing cardiocirculatory compliance and cardiocirculatory failure from the trend of the parameters computed from the functionality equations.

15. The method of claim 14 including the steps of design and monitoring of patient-specific rehabilitation programs for treatment of dysfunctionalities, myocardial impairment, critical illness, and effectuating cardiocirculatory compliance and cardiocirculatory failure.

16. The method of claim 14 including the steps of design and monitoring subject-specific conditioning programs.

17. The method of claim 14 including the steps of evaluating the efficacy of drugs by reference to the zones of criticalities and the trend of the parameters computed from the functionality equations.

18. The method of claim 14 including the steps of determining outcome of an intervention by reference to functionality and the time trends thereof.

19. The method of claim 14 wherein said step of measuring includes all electromechanical signals deriving signals corresponding ventricular volumes, ventricular and atrial cross-sectional areas, ventricular, arterial, central venous, pulmonary artery, carotid, atrial, jugular, and radial pressures, inspired and expired volumes of gases, electrocardiographic, and echocardiographic signals, time for completion of one heart beat, pre-selected times, and combinations thereof.

20. The method of claim 14 wherein said step of measuring includes catheters, pressure transducers, pressure cuffs, electrodes, and echocardiographic sensors.

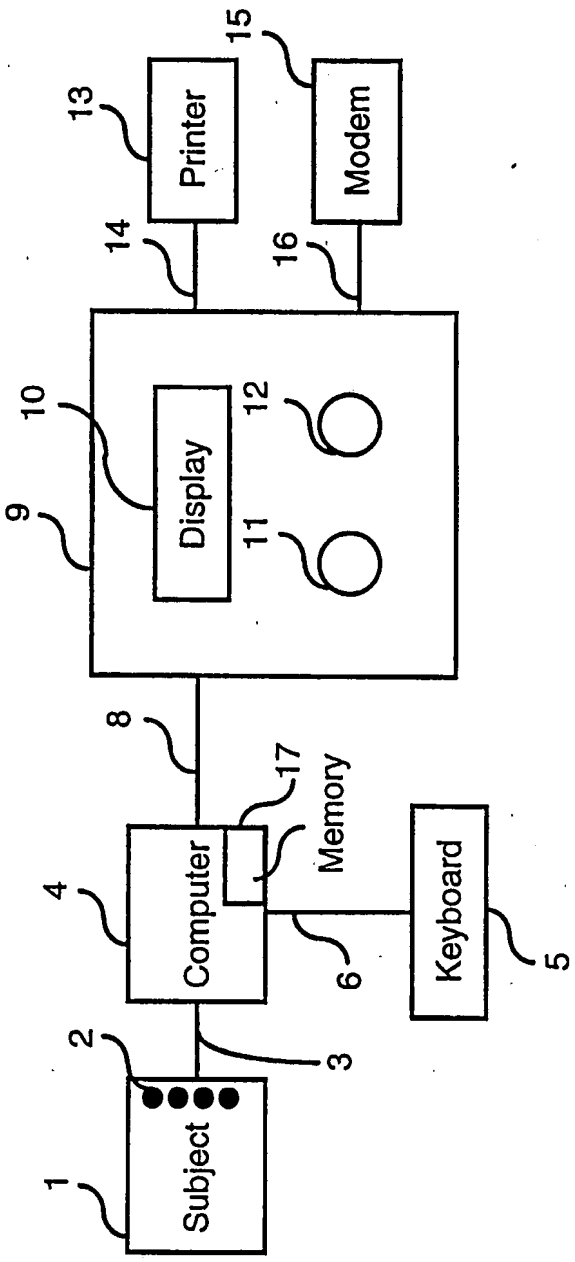


Fig. 3

US005810011A

United States Patent [19]

Kunig

[11] Patent Number: 5,810,011

[45] Date of Patent: Sep. 22, 1998

[54] METHOD AND APPARATUS FOR MEASURING MYOCARDIAL IMPAIRMENT AND DYSFUNCTIONS FROM EFFICIENCY AND PERFORMANCE DIAGRAMS

[76] Inventor: Sabine Vivian Kunig, P.O. Box 192, Saltsburgh, Pa. 15681

[21] Appl. No.: 607,789

[22] Filed: Feb. 27, 1996

[51] Int. Cl.[6] A61B 5/02

[52] U.S. Cl. 128/668

[58] Field of Search 128/668, 691, 128/713, 672

[56] References Cited

U.S. PATENT DOCUMENTS

5,046,502	9/1991	Kunig	128/668
5,370,122	12/1994	Kunig et al.	128/668
5,584,298	12/1996	Kabal	128/677

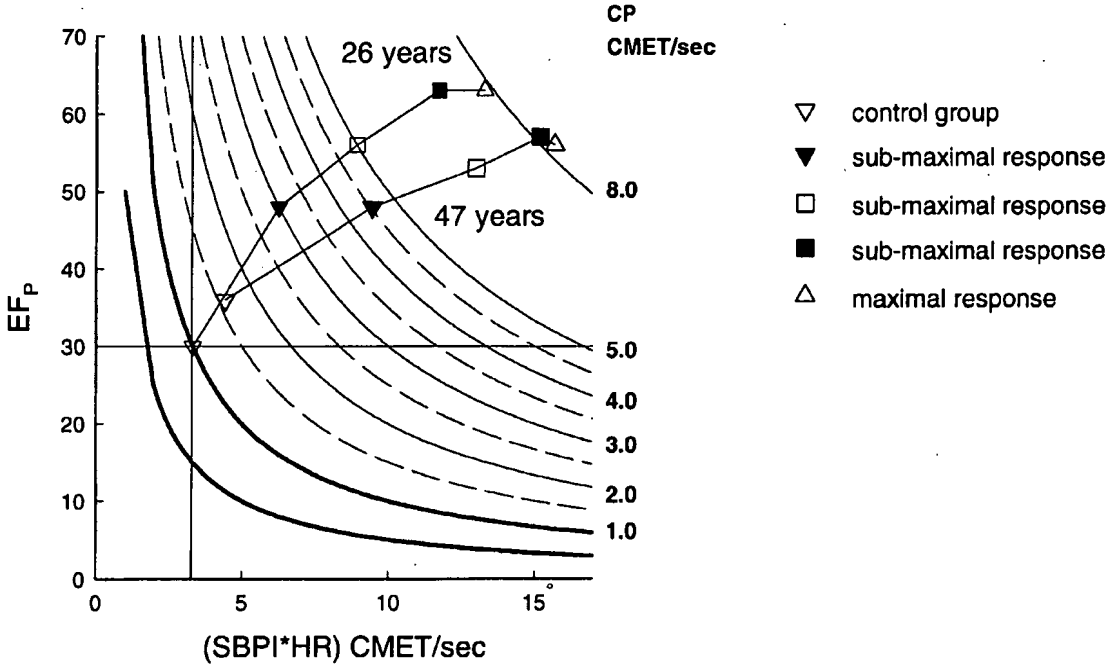
Primary Examiner—William E. Kamm
Assistant Examiner—George R. Evanisko
Attorney, Agent, or Firm—Clifford A. Poff

[57] ABSTRACT

A diagnostic and monitoring device is used to diagnose myocardial impairment, dysfunctions, and the state of critical illness. The device has utility to design and monitor therapies for differential treatment of myocardial impairment, dysfunctions, rehabilitation, and conditioning exercises. Ventricular size, pressures, and heart rate are measured to determine cardiac efficiency given by volume and pressure efficiency components, cardiac work and myocardial oxygen consumption, the data being displayed in efficiency and performance diagrams to diagnose myocardial impairment from cardiac efficiency data, dysfunctions from myocardial oxygen consumption data, and the state of critical illness from cardiac work data.

19 Claims, 5 Drawing Sheets

Performance Diagram



While the present invention has been described in connection with the preferred embodiments of the various figures, it is to be understood that other similar embodiments may be used or modifications and additions may be made to the described embodiment for performing the same function of the present invention without deviating therefrom. Therefore, the present invention should not be limited to any single embodiment, but rather construed in breadth and scope in accordance with the recitation of the appended claims.

I claim:

1. A cardiac diagnostic device for monitoring a subject, said device including;

means for measuring physiological parameters of such subject;

means responsive to measurements of physiological parameters of such subject for deriving values of cardiac efficiency and myocardial oxygen consumption;

means for establishing a boundary of physiological criticality in a first reference frame of cardiac efficiency versus myocardial oxygen consumption; and

means using said cardiac efficiency and myocardial oxygen consumption of such subject for establishing a subject data point in said first reference frame whereby a comparison is allowed between said subject data point and said boundary of physiological criticality.

2. The cardiac diagnostic device according to claim 1 wherein said boundary of physiological criticality includes at least one curve in said first reference frame, said curve containing at least one reference point representing an absence of dysfunction and myocardial impairment.

3. The cardiac diagnostic device according to claim 2 wherein said means responsive to said measurements further derives cardiac pressure efficiency and cardiac volume efficiency for such subject;

and wherein said means for establishing a boundary of physiological criticality further establishes at least one cardiac efficiency curve in a cardiac efficiency reference frame of cardiac volume efficiency versus cardiac pressure efficiency, said cardiac efficiency curve containing a basal reference point representing a basal value for cardiac volume efficiency and a basal value for cardiac pressure efficiency;

and wherein said means for establishing a subject data point in said first reference frame further establishes a second subject data point in said cardiac efficiency reference frame using said derived cardiac pressure efficiency and cardiac volume efficiency whereby a comparison is allowed between said second subject data point and said cardiac efficiency curve for the left or right heart.

4. The cardiac diagnostic device according to claim 3 wherein said cardiac efficiency curve consists of a plurality of cardiac efficiency curves in said cardiac efficiency reference frame.

5. The cardiac diagnostic device according to claim 3 wherein said cardiac efficiency is defined as the product of cardiac volume efficiency and cardiac pressure efficiency.

6. The cardiac diagnostic device according to claim 3 wherein said cardiac efficiency curve represents a cardiac basal efficiency value for all values of cardiac volume efficiency and cardiac pressure efficiency.

7. The cardiac diagnostic device according to claim 3 further including using said subject data point and said curve in said first reference frame and second subject data point and said cardiac efficiency curve in said cardiac efficiency frame to design and monitor therapies for differential treatment of myocardial impairment or dysfunction.

8. The cardiac diagnostic device according to claim 3 further including using said subject data point and said curve in said first reference frame and second subject data point and said cardiac efficiency curve in said cardiac efficiency frame to design and monitor exercise programs for cardiac rehabilitation and conditioning of subjects.

9. The cardiac diagnostic device according to claim 2 wherein said means for establishing a boundary includes a second curve establishing a zone of physiological criticality with said at least one curve at which death is imminent.

10. the cardiac diagnostic device according to claim 2 wherein said at least one curve further establishes a basal level of cardiac work expended, and wherein said means for establishing further provides a plurality of curves representing elevated levels of cardiac work expended relative to said basal level.

11. The cardiac diagnostic device according to claim 1 wherein said measurements of physiological parameters include signals representative of ventricular size, ventricular blood pressure, time for completion of one cardiac cycle, and heart rate.

12. The cardiac diagnostic device according to claim 1 wherein said means responsive to physiological measurements of physiological parameters further derives volume efficiency, pressure efficiency, cardiac work and available energy for conversion to cardiac work.

13. A method of diagnosing myocardial impairments, dysfunctions and physiological criticality of a subject, said diagnostic method including the steps of:

monitoring such subject to obtain measurements representative of physiological parameters;

determining cardiac efficiency and myocardial oxygen consumption for such subject using said representative measurements;

establishing a boundary of physiological criticality in a first reference frame of cardiac efficiency versus myocardial oxygen consumption;

establishing a subject data point in said first reference frame which represents said determined cardiac efficiency and myocardial oxygen consumption for such subject; and

comparing said subject data point with said boundary to indicate physiological criticality.

14. The method according to claim 13 including the further steps of:

providing at least one curve in said first reference frame containing at least one reference point which represents an absence of dysfunction and myocardial impairment; and

comparing said subject data point to said at least one curve to diagnose myocardial impairments and dysfunctions of the left or right heart of such subject using said reference point of said curve.

15. The method according to claim 14, wherein said diagnosis of impairment is made by comparing the position of said data point with said reference point with respect to said cardiac efficiency of said first reference frame, and wherein said diagnosis of dysfunction is made by comparing the position of said data point with said reference point with respect to said myocardial oxygen consumption of said first reference frame.

16. The method according to claim 14, including the further steps of:

determining cardiac pressure efficiency and cardiac volume efficiency for such subject using said representative measurements;

providing at least one cardiac efficiency curve in a cardiac efficiency reference frame of cardiac volume efficiency versus cardiac pressure efficiency, said cardiac efficiency curve containing an basal reference point representing a basal value for cardiac volume efficiency and a basal value for cardiac pressure efficiency;

establishing a second subject data point in said cardiac efficiency reference frame using said determined cardiac pressure efficiency and cardiac volume efficiency;

comparing said second subject data point with said cardiac efficiency curve to determine more specifically a cardiac condition and to aid in designing therapies affecting said impairments and dysfunctions.

17. The method according to claim 16 wherein said comparison of said second subject data point with said cardiac efficiency curve involves comparing the volume efficiency of said second subject data point with the basal volume efficiency and comparing the pressure efficiency of said second subject data point with the basal pressure efficiency.

18. The method according to claim 16 further including the step of designing and monitoring therapies, exercise rehabilitation programs in response to said step of comparing.

19. the cardiac diagnostic device according to claim 12, wherein said means for establishing further provides a plurality of progression curves each in one progress reference frame, each of said progression reference frames having one of said derived values versus time, said progression curves containing points representing instant values of said derived values or their time derivatives for such subject at different times during a therapy treatment or an exercise program.

* * * * *

46/7/19 (Item 19 from file: 350) **Links**
Derwent WPIX

0013641030 *Drawing available*
WPI Acc no: 2003-736960/200370
XRPX Acc No: N2003-589509
Electronic information recording system for medical applications, has tablet function display of infinite length, and which is divided into several sections for displaying input data while storing input data electronically
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Inventor: ASHIHARA T; IGARASHI T; NAKAZAWA K; SAKACHI H; YAO T; YOKOTA H

Patent Family (3 patents, 2 countries)

Patent Number	Kind	Date	Application Number	Kind	Date	Update	Type
JP 2003225209	A	20030812	JP 2002337721	A	20021121	200370	B
US 20040003142	A1	20040101	US 2002300890	A	20021121	200402	E
US 6886061	B2	20050426	US 2002300890	A	20021121	200528	E

Priority Applications (no., kind, date): JP 2001357736 A 20011122

Patent Details

Patent Number	Kind	Lan	Pgs	Draw	Filing Notes
JP 2003225209	A	JA	19	16	

Alerting Abstract JP A
NOVELTY - The recording system has input-output unit (4) and tablet function display screen which extends in preset direction and is divided into date, compressed and original image display sections. A control and calculation unit (3) displays the information input using pen in corresponding display sections, while the input information are converted into electronic information and stored in memory (2).
DESCRIPTION - INDEPENDENT CLAIMS are also included for the following:

1. electronic information recording control program; and
2. image display control method.

USE - For recording information e.g. **medical reports** electronically using tablet pen, for medical applications.
ADVANTAGE - Enables displaying and electronic recording of input information, reliably without the need of menu, buttons. Hence the need of using paper for printing medical information are eliminated.
DESCRIPTION OF **DRAWINGS** - The figure shows the block **diagram** of the electronic information recording system. (**Drawing** includes non-English language text).
2 memory

3 control and calculation unit
4 input-output unit
5 input unit
6 output unit
8 doctor

Title Terms /Index Terms/Additional Words: ELECTRONIC; INFORMATION; **RECORD**; SYSTEM; MEDICAL; APPLY; TABLET; FUNCTION; DISPLAY; INFINITE; LENGTH; DIVIDE; SECTION; INPUT; DATA; STORAGE

Class Codes

International Patent Classification

IPC	Class Level	Scope	Position	Status	Version Date
A61B-005/00; G06F-003/00			Main		"Version 7"
G06F-013/00; G06F-017/60; G06F-003/03			Secondary		"Version 7"

US Classification, Issued: 710001000, 710073000, 710001000, 710014000, 710072000, 710074000, 705001000, 705002000, 705003000, 705004000, 705005000 , 600523000

File Segment: EngPI; EPI;
DWPI Class: S05; T01; T04; P31
Manual Codes (EPI/S-X): **S05-D07**; T01-C02B1; T01-J06A; T04-F02A5

Original Publication Data by Authority

Japan

Publication No. JP 2003225209 A (Update 200370 B)
Publication Date: 20030812
ELECTRONIC INFORMATION RECORDING SYSTEM AND CONTROL PROGRAM
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YAO TAKENORI

SAKACHI HIROYUKI
Language: JA (19 pages, 16 drawings)
Application: JP 2002337721 A 20021121 (Local application)
Priority: JP 2001357736 A 20011122
Original IPC: G06F-17/60(-) A61B-5/00(A) G06F-3/00(B) G06F-3/03(B)
Current IPC: G06F-17/60(-) A61B-5/00(A) G06F-3/00(B) G06F-3/03(B)

United States

Publication No. US 20040003142 A1 (Update 200402 E)
Publication Date: 20040101
Electronic record system and control program
Assignee: NEC CORPORATION (NIDE)
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Language: EN
Application: US 2002300890 A 20021121 (Local application)
Priority: JP 2001357736 A 20011122
Original IPC: G06F-3/00(A)
Current IPC: G06F-3/00(A)
Original US Class (main): 7101
Original Abstract: Disclosed is an electronic record system which dispenses with complicated operations using a menu and a button and handwriting input operation like paper writing can be achieved. A system is established and is provided with: an input/output unit device capable of inputting/outputting data by the direct writing on a display screen with a pen; and a control/arithmetic device connected to the input/output unit device and reflecting the data inputted on the display screen to the screen. In this system, an electronic record in the form of strip-shaped sheet with an infinite length extending in the longitudinal direction is displayed, data is directly inputted from the display screen as a stroke data, the inputted characters are converted into the character data by the use of a character recognition engine and the converted data is used as data format available in a secondary use such as a data search, and various functions are driven by a predetermined pen operation.
Claim: What is claimed is:

1. 1. An electronic record system comprising an input/output unit device which has a display device with a tablet function and which executes input operation by directly writing input data on the display device with a pen, and a control/arithmetic device, connected to the input/output unit device, for reflecting on the display device the input data entered on the display device, wherein the control/arithmetic device is adapted so as to display, on the display device, a record screen in which the input data is intuitively written by direct handwriting and so as to establish an electronic record on the basis of the data inputted on the medical record screen by the handwriting.

Publication No. US 6886061 B2 (Update 200528 E)
Publication Date: 20050426
Electronic record system and control program device with display and tablet function for manipulating display area functions with pen stylus
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Agent: Sughrue Mion, PLLC
Language: EN
Application: US 2002300890 A 20021121 (Local application)
Priority: JP 2001357736 A 20011122
Original IPC: G06F-3/00(A) G06F-13/00(B)
Current IPC: G06F-3/00(A) G06F-13/00(B)
Original US Class (main): 71073
Original US Class (secondary): 7101 71014 71072 71074 7051 7052 7053 7054 7055 600523
Original Abstract: Disclosed is an electronic record system which dispenses with complicated operations using a menu and a button and handwriting input operation like paper writing can be achieved. A system is established and is provided with: an input/output unit device capable of inputting/outputting data by the direct writing on a display screen with a pen; and a control/arithmetic device connected to the input/output unit device and reflecting the data inputted on the display screen to the screen. In this system, an electronic record in the form of strip-shaped sheet with an infinite length extending in the longitudinal direction is displayed, data is directly inputted from the display screen as a stroke data, the inputted characters are converted into the character data by the use of a character recognition engine and the converted data is used as data format available in a secondary use such as a data search, and various functions are driven by a predetermined pen operation.
Claim:

1. 1. An electronic record system comprising:
   - an input/output unit device which has a display device with a tablet function and which executes input operation by directly writing input data on a record screen displayed on the display device with a pen; and
   - a control/arithmetic device, connected to the input/outout unit device, for processing the handwritten input data onto the display device, so as to formulate an electronic record on the basis of the handwritten input data,
   - wherein the record screen of the display device is divided into a reduced-size display area for past information recorded on a past date and an actual size display area for current information recorded by handwriting,
   - wherein the control/arithmetic device is configured so that the past information on the reduced-size display

area is duplicated onto the actual-size display area by drawing, by the use of the pen, a circular-like shape which surrounds desired past information displayed on the reduced-size display area and by executing drawing from the inside of the handwritten and substantial circle to the outside.

US006886061B2

(12) **United States Patent**
Yokota et al.

(10) **Patent No.: US 6,886,061 B2**
(45) **Date of Patent: Apr. 26, 2005**

(54) **ELECTRONIC RECORD SYSTEM AND CONTROL PROGRAM DEVICE WITH DISPLAY AND TABLET FUNCTION FOR MANIPULATING DISPLAY AREA FUNCTIONS WITH PEN STYLUS**

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(73) Assignees: **NEC Corporation**, Tokyo (JP); **Takeo Igarashi**, Kanagawa (JP); **Kazuo Nakazawa**, Osaka (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 55 days.

(21) Appl. No.: **10/300,890**

(22) Filed: **Nov. 21, 2002**

(65) **Prior Publication Data**

US 2004/0003142 A1 Jan. 1, 2004

(30) **Foreign Application Priority Data**

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(51) **Int. Cl.**[7] **G06F 3/00**; G06F 13/00

(52) **U.S. Cl.** **710/73**; 710/1; 710/14; 710/72; 710/74; 705/1; 705/2; 705/3; 705/4; 705/5; 600/523

(58) **Field of Search** 710/1, 14, 72–74; 702/1–5; 600/523

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,561,446	A *	10/1996	Montlick	345/173
5,724,985	A *	3/1998	Snell et al.	600/523
5,867,821	A *	2/1999	Ballantyne et al.	705/2
6,314,405	B1 *	11/2001	Richardson	705/3
6,393,404	B1 *	5/2002	Waters et al.	705/2
6,421,650	B1 *	7/2002	Goetz et al.	705/3
6,711,547	B1 *	3/2004	Glover	705/2
2002/0032584	A1 *	3/2002	Doctor et al.	705/3
2002/0091659	A1 *	7/2002	Beaulieu et al.	706/62

FOREIGN PATENT DOCUMENTS

JP 2000-325314 A 11/2000

* cited by examiner

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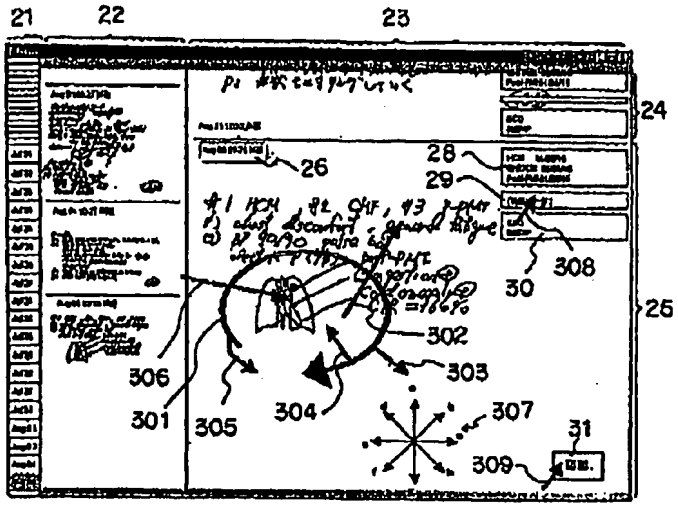
(57) **ABSTRACT**

Disclosed is an electronic record system which dispenses with complicated operations using a menu and a button and handwriting input operation like paper writing can be achieved. A system is established and is provided with: an input/output unit device capable of inputting/outputting data by the direct writing on a display screen with a pen; and a control/arithmetic device connected to the input/output unit device and reflecting the data inputted on the display screen to the screen. In this system, an electronic record in the form of strip-shaped sheet with an infinite length extending in the longitudinal direction is displayed, data is directly inputted from the display screen as a stroke data, the inputted characters are converted into the character data by the use of a character recognition engine and the converted data is used as data format available in a secondary use such as a data search, and various functions are driven by a predetermined pen operation.

41 Claims, 12 Drawing Sheets



time-series information, for example, measurement of body temperature, prescription, and inspection items is displayed thereon. The sub-screen is scrolled in a drawing direction (horizontal direction) by a drawing **701** with the control mode from the inside of a scroll box.

Also, as shown in FIG. **16**, it is possible to adjust the zoom level (display level) by a drawing **801** with the control mode performed after pointing the pen on the edge of the scroll box **71**. Therefore, it is possible to overlook the long-term information by reducing the zoom level in the horizontal direction.

In addition, the selection of prescription can be performed on this sub-screen, and it is also possible to specify the period of the prescription by painting the squares of the prescription portion. This operation makes it possible to modify the existing period of prescription and to copy the past prescription. Note that, when a new period is specified, the medicine list selection screen shown in FIG. **5** is displayed so as to select the medicine to be prescribed.

In addition, the sub-screen can be also used to output the medical record screen of a patient having the same symptoms.

In the foregoing, the electronic medical record system according to the embodiments has been described. However, the system is not limited to the embodiments. For example, the settings of the three conditions for determining the partition line (long straight line extending in the horizontal direction) can be appropriately modified. The settings of the three conditions are: the ratio of the total length of the drawn stroke and the straight distance of the stroke (1.2 times in this embodiment); the ratio of the circumscribed rectangle of the drawn stroke to the width of the drawing area (0.5 times in this embodiment); and maximum value of the length of the circumscribed rectangle of the drawn stroke (100 pixels in this embodiment). It is also possible to determine the straight lines in every direction by applying these algorithms.

Similarly, the settings of the conditions for determining the area selection can be appropriately modified. The settings of the area selection is: the ratio of the total length to the straight distance of the stroke (twice in this embodiment).

In addition, the embodiment exemplifies the electronic medical record system. However, the present invention can be realized as a control program for performing the same operations as described above by combining a general-purpose computer and a display device having a tablet function.

The present invention realized by the above-described configurations can achieve the following advantages.

First, since the medical record is displayed as a scroll with an infinite length extending in a longitudinal direction, the input of the medical information is easily performed without taking care of the working area.

Second, since most of the operations for the input are similar to those of writing on the paper by using a pen, the transition from the conventional medical care using the paper writing to the system of the present invention can be easily performed.

Third, since the size-reduced display area and the actual-size display area can be displayed at the same time and can be scrolled independently, the input can be performed while refereeing to the data in the past.

Fourth, since the date display area, the reduced-size display area, and the actual-size display area can be displayed together on a screen and the system has a function to display the past data in succession, it is possible to easily and rapidly search the required data from a great number of medical records.

Fifth, since the past data can be pasted on the current data sheet by only the operations of selecting the past data and drawing a line, it is possible to easily divert the past data.

Sixth, since the arrangement effective to select the medicines to be prescribed is used, it is possible to easily and rapidly select the required medicine from a great number of medicines.

Seventh, since the functions registered in the pie menu can be selected by the simple operation with a pen, it is possible to rapidly select a useful function.

Eighth, since the system can perform the character recognition of the handwritten characters to treat the characters as the character data, the high-speed search with key input can be realized.

Ninth, since many schema images are prepared and the schema image can be used as a three-dimensional schema by the use of the three-dimensional figure forming function, it is possible to easily paste and draw the affected portion of a patient in the findings.

Tenth, since a translucent color is used to show the selected area, it is possible to easily determine the selected area.

While the present invention has thus far been described in a few embodiments thereof, it will be readily possible for those skilled in the art to put the present invention into practice in various other manners. For example, the present invention is applicable to a general electronic record system that has an image screen instead of the medical record screen. In such a general electronic record system, a general electronic record is made up by entering general information and a general image, instead of medical information and a schema, respectively. Moreover, a general request and general items or products are used in lieu of the-prescription request and the medicines, respectively. At any rate, the present invention can provide a user-friendly electronic record system and a control program thereof, in which the free-writing input is realized to reduce the stress due to the complicated input operation.

What is claimed is:

1. An electronic record system comprising:

an input/output unit device which has a display device with a tablet function and which executes input operation by directly writing input data on a record screen displayed on the display device with a pen; and

a control/arithmetic device, connected to the input/outout unit device, for processing the handwritten input data onto the display device, so as to formulate an electronic record on the basis of the handwritten input data,

wherein the record screen of the display device is divided into a reduced-size display area for past information recorded on a past date and an actual size display area for current information recorded by handwriting,

wherein the control/arithmetic device is configured so that the past information on the reduced-size display area is duplicated onto the actual-size display area by drawing, by the use of the pen, a circular-like shape which surrounds desired past information displayed on the reduced-size display area and by executing drawing from the inside of the handwritten and substantial circle to the outside.

2. The electronic record system according to claim **1**, wherein the electronic record is computerized like a stripe-

shaped sheet with an infinite length extending in a vertical direction of the record screen, and the control/arithmetic device is configured so that the electronic record displayed on the display device can be scrolled.

3. The electronic record system according to claim 1, wherein the record screen comprises a reduced-size display area on which past information on a past date specified by date information is longitudinally displayed in a reduced size, and an actual-size display area on which detailed information is handwritten and current information is longitudinally displayed in an actual size.

4. The electronic record system according to claim 3, wherein the record screen further includes a date display area for displaying a succession of dates longitudinally.

5. The electronic record system according to claim 4, wherein the control/arithmetic device is configured so that the date display area, the size-reduced display area and the actual-size display area are independently longitudinally scrolled.

6. The electronic record system according to claim 1, wherein the input data comprises written information and data processing information, and the input/output unit device is configured so as to select a writing operation and data processing operation in accordance with an input mode of the pen.

7. The electronic record system according to claim 1, wherein the written information comprises a written record and partition line information that is entered by linear drawing in the horizontal direction of the record screen, so as to end the writing operation, the control/arithmetic device comprising determination means for determining whether the written information is either the written record or the partition line information, and wherein, when it is determined that the written information is the partition line information, a drawn line is not treated as stroke data and a partition line is displayed on the record screen to store the written information.

8. The electronic record system according to claim 7, wherein the determination means determines whether the written information is the written record or the partition line information, with reference to a relationship between an entire length of the drawing and a straight distance from a starting point to an end point of the drawing, a relationship between a width of a line segment formed by the drawing and a width of the record screen, and a straight distance in the vertical direction of the line segment formed by the drawing.

9. The electronic record system according to claim 1, wherein the data processing information comprises area selection information inputted by drawing so as to surround a desired area with a circle and pie menu process information inputted by linear drawing for executing processes registered in advance,

the control/arithmetic device comprising determination means for determining whether the inputted data is the area selection information or the pie menu process information; and wherein, when the determination means determines the inputted data as the area selection information, image processing to the selected desired area is performed, and when the determination means determines the inputted data as the pie menu process information, a data input support process or an application starting process is performed.

10. The electronic record system according to claim 9, wherein the image processing operation includes enlargement, reduction, rotation, movement, duplication, deletion, and character data conversion.

11. The electronic record system according to claim 9, wherein the control/arithmetic device is configured so that image processing operations are selected in accordance with a direction of the drawing performed across the selected area or the drawing performed in an optional direction from the drawn line.

12. The electronic record system according to claim 9, wherein the data input support process is for processing undo, redo and schema,

the control/arithmetic device being configured so that when the schema is selected, a schema image list is displayed and a desired schema image is duplicated on the electronic record by the use of the pen.

13. The electronic record system according to claim 12, wherein the application includes a computing function using handwriting character recognition and a three-dimensional figure forming function for converting the two-dimensional handwritten input or the schema image into a three-dimensional image.

14. The electronic record system according to claim 9, wherein the control/arithmetic device is configured so that the pie menu processes are selected in accordance with a direction of the drawing optionally performed so as not to cross the selected area.

15. The electronic record system according to claim 9, wherein the control/arithmetic device is configured so that when the determination means determines that the inputted data is the area selection information, an area surrounded with a substantial circle is colored with a translucent color to indicate that the area is selected.

16. The electronic record system according to claim 1, wherein the application is adapted to be operated by the use of a translucent window formed on the electronic record, and the application is adapted to be finished by a pen input on the outside of the window.

17. The electronic record system according to claim 1, wherein the control/arithmetic device is configured so that a request section is displayed on the record screen, while a list constituted of index sections and name sections assigned in each index section are displayed by the pen operation on the request section, and a desired name is displayed in the request section by operating the pen on the desired name.

18. The electronic record system according to claim 17, wherein the control/arithmetic device is configured so that an order of items displayed in the name section is sorted in accordance with a frequency of selection of the items, and the list is dynamically modified by increasing/decreasing the number of the names displayed in the name section.

19. The electronic record system according to claim 17, wherein when the pen operation on the index section in the list is performed, all names linked with the index are displayed, and a desired name is displayed on the request section and registered in the name section by the pen operation on the desired name.

20. A computer-readable memory including a program comprising instructions, which when executed cause an electronic record system comprising an input/output unit device which has a display device with a tablet function and which executes input operation by directly writing input data on the display device with a pen;

and a control/arithmetic device, connected to the input/output unit device, for reflecting on the display device the input data entered on the display device to:

display on the display device a record screen in which the input data is intuitively written by direct handwriting; and

establish an electronic record on the basis of the handwritten input information on the record screen dis-

played by the display step, wherein the electronic record is computerized so as to be a stripe-shaped sheet with an infinite length extending in a vertical direction of the display screen, and the control/arithmetic device is configured so that the electronic record displayed on the display device is scrolled.

21. The computer-readable memory according to claim **20**, wherein the record screen comprises a reduced-size display area on which past information in a past date specified by date information is longitudinally displayed in a reduced size, and an actual-size display area on which detailed information is handwritten and current information is longitudinally displayed in an actual size.

22. The computer-readable memory according to claim **21**, wherein the record screen further comprises a date display area in which a succession of dates are longitudinally displayed.

23. The computer-readable memory according to claim **22**, which is constituted so that the date display area, the size-reduced display area and the actual-size display area are independently longitudinally scrolled.

24. A computer-readable memory including a program comprising instructions, which when executed cause an electronic record system comprising an input/output unit device which has a display device with a tablet function and which executes input operation by directly writing input data on the display device with a pen, and a control/arithmetic device, connected to the input/output unit device, for reflecting on the display device the input data entered on the display device to:

display on the display device a record screen in which the input data is intuitively written by direct handwriting; and

establish an electronic record on the basis of the handwritten input information on the record screen displayed by the display step,

wherein the electronic record is computerized so as to be a stripe-shaved sheet with an infinite length extending in a vertical direction of the display screen, and the control/arithmetic device is configured so that the electronic record displayed on the display device is scrolled,

wherein the record screen comprises a reduced-size display area on which past information in a past date specified by date information is longitudinally displayed in a reduced size, and an actual-size display area on which detailed information is handwritten and current information is longitudinally displayed in an actual size,

wherein the record screen further comprises a date display area in which a succession of dates are longitudinally displayed,

which is constituted so that the date display area, the size-reduced display area and the actual-size display area are independently longitudinally scrolled, and

wherein the date display area and the reduce-size display area are scrolled together by vertical drawing on these areas, and desired past information is duplicated on the actual-size display area by performing the drawing so as to surround a desired region of the past information displayed on the reduced-size display area with a substantial circle and the drawing from the inside of the circle to the outside.

25. The computer-readable memory according to claim **24**, wherein the inputted data comprises written information and data processing information;

the instructions further comprising causing the electronic record system to select a writing operation and a data processing operation in accordance with an input mode of the pen.

26. The computer-readable memory according to claim **25**, wherein the written information comprises a written record and partition line information that is inputted by linear drawing in the horizontal direction of the display screen, so as to finish the writing operation;

the instructions further causing the electronic record system to:

determine whether the written information is the written record or the partition line information; and

treat a drawn line as no stroke data when it is determined that the written information is the partition line information, to display a partition line on the record display screen to store the written information.

27. The computer-readable memory according to claim **26**, wherein the determination step determines whether the written information is either the written record or the partition line information, on the basis of a relationship between an entire length of the drawing and the straight distance between a starting point and an end point of the drawing, a relationship between a width of a line segment formed by the drawing and a width of the medical record screen, and a straight distance in the vertical direction of the line segment formed by the drawing.

28. The computer-readable memory according to claim **27**, wherein the data processing information comprises area selection information inputted by drawing so as to surround a desired area with a circle, pie menu process information inputted by linear drawing for executing processes registered in advance;

the instructions further causing the electronic record system to:

judge whether the inputted data is the area selection information or the pie menu process information;

carry out image processing to the selected area when the judging step judges the area selection information; and

carry out a data input support process or an application starting process when the judging step judges the pie menu process information.

29. The computer-readable memory according to claim **28**, wherein the image processing includes enlargement, reduction, rotation, movement, duplication, deletion, and character data conversion.

30. The computer-readable memory according to claim **29**, which is constituted so that the image processing operations are selected in accordance with a direction of the drawing performed across the selected area or the drawing performed in an optional direction from the drawn line.

31. The computer-readable memory according to claim **30**, wherein the data input support process is for processing undo, redo and schema;

the control program being configured so that when the schema is selected, a schema image list is displayed and a desired schema image can be duplicated on the electronic record by the pen operation.

32. The computer-readable memory according to claim **31**, wherein the application includes a computing function using handwriting character recognition and a three-dimensional figure forming function for converting the two-dimensional handwritten input or the schema image into a three-dimensional image, and the respective functions work in cooperation with each other.

33. The computer-readable memory according to claim **32**, which is constituted so that the pie menu processes are

selected in accordance with a direction of the drawing optionally performed so as not to cross the selected area.

34. The computer-readable memory according to claim **33**, which is constituted so that an area surrounded with a substantial circle is colored with a translucent color to indicate that the area is selected, when the judging step judges that the inputted data is the area selection information.

35. The computer-readable memory according to claim **34**, wherein the application is adapted to be operated by the use of a translucent window formed on the electronic record, and the application is adapted to be finished by a pen input on the outside of the window.

36. The computer-readable memory according to claim **35**, which is constituted so that a request section is displayed on the record screen while a list comprising index sections and name sections assigned in each index section are displayed by the pen operation on the request section, and a desired name is displayed in the request section by the pen operation on the desired name.

37. The computer-readable memory according to claim **36**, wherein an order of items displayed in the name section is sorted in accordance with a frequency of selection of the items, and the list is dynamically modified by increasing/decreasing the number of names displayed in the name section.

38. The computer-readable memory according to claim **37**, wherein when the pen operation on the index section in the list is performed, all names linked with the index are displayed, and a desired name is displayed on the request section and registered in the name section by the pen operation on the desired name.

39. The electronic record system claimed in claim **1**, wherein the electronic record is an electronic medical record.

40. The control program claimed in claim **20**, wherein the electronic record is an electronic medical record.

41. The electronic record system according to claim **4**, wherein the control/arithmetic device is configured so that the date display area and the reduced-size display area are scrolled together by vertical drawing on these areas.

* * * * *

46/7/57 (Item 57 from file: 350) **Links**
Derwent WPIX

0008137186 *Drawing available*
WPI Acc no: 1997-237422/
XRPX Acc No: N1997-196091
Electrocardiogram or electroencephalogram time series measurement signal classification system - uses calculated entropies for measured signal for determining information flow used for signal classification
Patent Assignee: SIEMENS AG (SIEI)
Inventor: DECO G; SCHUERMANN B

Patent Family (5 patents, 19 countries)

Patent Number	Kind	Date	Application Number	Kind	Date	Update	Type
DE 19610847	C1	19970430	DE 19610847	A	19960319	199722	B
WO 1997035267	A1	19970925	WO 1997DE416	A	19970305	199744	E
EP 888590	A1	19990107	EP 1997914162	A	19970305	199906	E
			WO 1997DE416	A	19970305		
JP 2000506416	W	20000530	JP 1997533019	A	19970305	200033	E
			WO 1997DE416	A	19970305		
US 6266624	B1	20010724	WO 1997DE416	A	19970305	200146	E
			US 1998142265	A	19980903		

Priority Applications (no., kind, date): DE 19610847 A 19960319

Patent Details

Patent Number	Kind	Lan	Pgs	Draw	Filing Notes	
DE 19610847	C1	DE	10	5		
WO 1997035267	A1	DE	22	5		
National Designated States,Original	JP US					
Regional Designated States,Original	AT BE CH DE DK ES FI FR GB GR IE IT LU MC NL PT SE					
EP 888590	A1	DE			PCT Application	WO 1997DE416
					Based on OPI patent	WO 1997035267
Regional Designated States,Original	DE FR GB					
JP 2000506416	W	JA	16		PCT Application	WO 1997DE416
					Based on OPI patent	WO 1997035267
US 6266624	B1	EN			PCT Application	WO 1997DE416
					Based on OPI patent	WO 1997035267

Alerting Abstract DE C1
The classification system uses a processor for calculating the applicable signal entropies, used for determining at least one information flow for a given number of future sampling points, used for classification of the measured signals.
Pref. the entropies are calculated from summation functions for the sample values of the **electrocardiogram** or electroencephalogram signal, the subsequent classification effected on dependence on whether or not the information flow **graph** has a **curved** shape.
ADVANTAGE - Simple binary classification of **electrocardiogram** or electroencephalogram signals.

Title Terms /Index Terms/Additional Words: ECG; EEG; TIME; SERIES; MEASURE; SIGNAL; CLASSIFY; SYSTEM; CALCULATE; DETERMINE; INFORMATION; FLOW

Class Codes

International Patent Classification

IPC	Class Level	Scope	Position	Status	Version Date
A61B-005/0452; **G06F-017/00**; **G06F-017/10**; **G06F-017/18**			Main		"Version 7"
A61B-005/03; **A61B-005/0402**; **A61B-005/0476**; **G06F-015/18**; **G06F-159/00**; **G06F-019/00**			Secondary		"Version 7"

US Classification, Issued: 702073000, 702079000, 128091000

File Segment: EngPI; EPI;
DWPI Class: S05; T01; P31
Manual Codes (EPI/S-X): **S05-D01A1**; **S05-D01A2**; T01-J03; T01-J04B2; T01-J06A

Original Publication Data by Authority

Germany

Publication No. DE 19610847 C1 (Update 199722 B)
Publication Date: 19970430
Verfahren zur Klassifikation einer messbaren Zeitreihe, die eine vorgebbare Anzahl von Abtastwerten aufweist, beispielsweise eines elektrischen Signals, durch einen Rechner und Verwendung des Verfahrens
Assignee: Siemens AG, 80333 Muenchen, DE (SIEI)
Inventor: Deco, Gustavo, Dr., 80636 Muenchen, DE
Schuermann, Bernd, Prof. Dr.rer.nat.habil., 85778 Haimhausen, DE
Language: DE (10 pages, 5 drawings)
Application: DE 19610847 A 19960319 (Local application)
Original IPC: G06F-17/10(A) A61B-5/03(B) A61B-5/0402(B) A61B-5/0476(B) G06F-19/00(B)
Current IPC: G06F-17/10(A) A61B-5/03(B) A61B-5/0402(B) A61B-5/0476(B) G06F-19/00(B)

Claim:

- 1. Verfahren zur Klassifikation einer messbaren Zeitreihe, die eine vorgebbare Anzahl von Abtastwerten aufweist, beispielsweise eines elektrischen Signals, durch einen Rechner,
  - - bei dem bedingte Entropien ermittelt werden,
  - - bei den aus den bedingten Entropien mindestens ein Informationsfluss fur eine vorgebbare Anzahl zukunftiger Abtastzeitpunkte (p) bestimmt wird, und
  - - bei den anhand des Informationsflusses eine Klassifikation der Zeitreihe durchgefuhrt wird.

EPO

Publication No. EP 888590 A1 (Update 199906 E)
Publication Date: 19990107
VERFAHREN ZUR KLASSIFIKATION EINER ZEITREIHE, DIE EINE VORGEBBARE ANZAHL VON ABTASTWERTEN AUFWEIST, BEISPIELSWEISE EINES ELEKTRISCHEN SIGNALS, DURCH EINEN RECHNER
METHOD OF CLASSIFYING A TIME SEQUENCE HAVING A PREDETERMINED NUMBER OF SAMPLING VALUES, FOR EXAMPLE AN ELECTRICAL SIGNAL, BY A COMPUTER
CLASSIFICATION PAR UN ORDINATEUR D'UNE SERIE CHRONOLOGIQUE PRESENTANT UN NOMBRE PREDEFINISSABLE DE VALEURS D'ECHANTILLONNAGE, PAR EXEMPLE D'UN SIGNAL ELECTRIQUE
Assignee: SIEMENS AKTIENGESELLSCHAFT, Wittelsbacherplatz 2, 80333 Muenchen, DE (SIEI)
Inventor: DECO, Gustavo, Klarastrasse 13, D-80636 Muenchen, DE
SCHURMANN, Bernd, Muenchener Strasse 35, D-85778 Haimhausen, DE
Language: DE
Application: EP 1997914162 A 19970305 (Local application)
WO 1997DE416 A 19970305 (PCT Application)
Priority: DE 19610847 A 19960319
Related Publication: WO 1997035267 A (Based on OPI patent)
Designated States: (Regional Original) DE FR GB
Original IPC: G06F-17/18(A) G06F-159:00(Z)
Current IPC: G06F-17/18(A) G06F-159:00(Z)
Original Abstract: The invention relates to a process in which conditional entropies are established for the sampling values and are used to determine an information flow for a predetermined number of future sampling points. The time sequence is classified using the information flow which reflects non-linear correlations between the sampling values. Classification between time sequences with sampling values correlated in a non-linear manner, and time sequences with sampling values which are randomly independent, is therefore possible.

Japan

Publication No. JP 2000506416 W (Update 200033 E)
Publication Date: 20000530
Assignee: SIEMENS AG (SIEI)
Inventor: DECO G

SCHUERMANN B
Language: JA (16 pages)
Application: JP 1997533019 A 19970305 (Local application)
WO 1997DE416 A 19970305 (PCT Application)
Priority: DE 19610847 A 19960319
Related Publication: WO 1997035267 A (Based on OPI patent)
Original IPC: A61B-5/0452(A) A61B-5/0476(B) G06F-15/18(B)
Current IPC: A61B-5/0452(A) A61B-5/0476(B) G06F-15/18(B)

United States

Publication No. US 6266624 B1 (Update 200146 E)
Publication Date: 20010724
Method conducted in a computer for classification of a time series having a prescribable number of samples.
Assignee: Siemens Aktiengesellschaft, Munich, DE (SIEI)
Inventor: Deco, Gustavo, Munchen, DE
Schurmann, Bernd, Haimhausen, DE
Agent: Schiff Hardin & Waite
Language: EN
Application: WO 1997DE416 A 19970305 (PCT Application)
US 1998142265 A 19980903 (Local application)
Priority: DE 19610847 A 19960319
Related Publication: WO 1997035267 A (Based on OPI patent)
Original IPC: G06F-17/00(A)
Current IPC: G06F-17/00(A)
Original US Class (main): 70273
Original US Class (secondary): 70279 12891
Original Abstract: A method for determining conditioned entropies for a prescribable plurality of future sampling times for a set of samples based upon an information flow. A classification of a time series is implemented on the basis of the information flow. The information flow reflects nonlinear correlations between the samples. A classification is thus possible between those time series whose samples are non-linearly correlated and those time series whose samples are stochastically independant.
Claim:

1. A method for classification of a time series, the method comprising:
   - gathering a prescribable plurality of samples of an electrical signal;
   - determining conditioned entropies relating to the samples;
   - determining at least one information flow for a prescribable plurality of future sampling times from the conditioned entropies; and
   - determining a classification of the time series based upon the information flow.

WIPO

Publication No. WO 1997035267 A1 (Update 199744 E)

US006266624B1

(12) **United States Patent**
Deco et al.

(10) **Patent No.: US 6,266,624 B1**
(45) **Date of Patent: Jul. 24, 2001**

(54) **METHOD CONDUCTED IN A COMPUTER FOR CLASSIFICATION OF A TIME SERIES HAVING A PRESCRIBABLE NUMBER OF SAMPLES**

(75) Inventors: **Gustavo Deco**, München; **Bernd Schürmann**, Haimhausen, both of (DE)

(73) Assignee: **Siemens Aktiengesellschaft**, Munich (DE)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/142,265**

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(86) PCT No.: **PCT/DE97/00416**

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§ 102(e) Date: **Sep. 3, 1998**

(87) PCT Pub. No.: **WO97/35267**

PCT Pub. Date: **Sep. 25, 1997**

(30) **Foreign Application Priority Data**

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(51) **Int. Cl.**[7] **G06F 17/00**
(52) **U.S. Cl.** **702/73**; 702/79; 128/91
(58) **Field of Search** 600/515; 128/901; 702/73, 79

(56) **References Cited**

FOREIGN PATENT DOCUMENTS

WO009725676 * 7/1997 (JP) G06F/17/00

WO009733238 * 2/1997 (WO) G06F/17/18

OTHER PUBLICATIONS

"Komolexitätsanalyse in der Kardiologie,"Morfill, Physikalische Blätter, vol. 50, No. 2, pp. 156–160, (1994.

"Entropy, Transinformation and Word Distribution of Information–Carrying Sequences," Ebeling et al., International Journal of Bifurcation and Chaos, vol. 5, No. 1, pp. 51–61, (1995).

Estimation Functions of Probability Distributions From a Finite Set of Samples, Wolpert et al., Physical Review E, vol. 52, No. 6, pp. 6841–6854, (Dec. 1995).

LICOX, GMS, Gesellschaft für Medizinische Sondentechnik mbH, Advanced Tissue Monitoring, no date.

"Time Series Analysis of Complex Dynamics in Physiology and Medicine," Glass et al., Medical Progress Through Technology, vol. 19, No. 3, pp. 115–128 (1993).

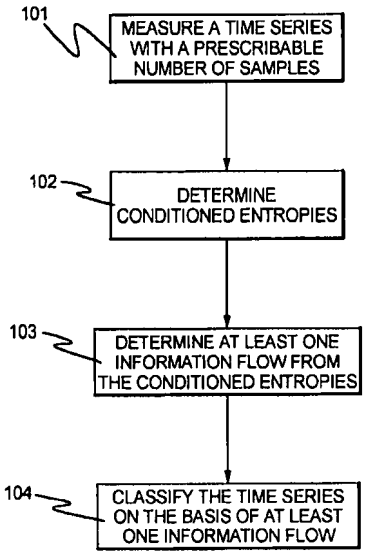
* cited by examiner

Primary Examiner—Kamini Shah
(74) *Attorney, Agent, or Firm*—Schiff Hardin & Waite

(57) **ABSTRACT**

A method for determining conditioned entropies for a prescribable plurality of future sampling times for a set of samples based upon an information flow. A classification of a time series is implemented on the basis of the information flow. The information flow reflects nonlinear correlations between the samples. A classification is thus possible between those time series whose samples are non-linearly correlated and those time series whose samples are stochastically independant.

8 Claims, 5 Drawing Sheets



METHOD CONDUCTED IN A COMPUTER FOR CLASSIFICATION OF A TIME SERIES HAVING A PRESCRIBABLE NUMBER OF SAMPLES

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention is directed to computerized method, i.e., a method conducted in a computer, for classification of a time series having a prescribable number of samples, such as an electrical signal.

2. Description of the Prior Art

In many technical fields wherein it is of interest to draw conclusions about the future behavior of the time series from measured time series. The prediction of the future "behavior" of the time series ensues given the assumption that the time series comprises non-linear correlations between the samples of the time series.

This problem also obtains to considerable significance in various medical fields, for example in cardiology. Specifically in the problem area of sudden cardiac death, it can be vital to recognize early warning signs of sudden cardiac death in order to initiate counter-measures against the occurrence of sudden cardiac death as early as possible.

It is known that a time series of an electrocardiogram that is not correlated describes a heart that is not at risk with respect to sudden cardiac death. A heart at risk with respect to sudden cardiac death is described by a time series of the electrocardiogram that comprises non-linear correlations between the samples of the time series (G. Morfill, "Komplexitätsanalyse in der Kardiologie, Physikalische Bl ätter," Vol. 50, No. 2, pp. 156–160, (1994)). It is also known from this Morfill article to determine time series of an electrocardiogram that describe hearts that are at risk with respect to sudden cardiac death from the graphic phase space presentation (Fourier transformation) of two successive heartbeats.

The method disclosed in this Morfill article exhibits all of the disadvantages that are typical of empirical methods. In particular, the error susceptibility of graphic interpretations by a human, the problem of setting a threshold from which a time series is classified as at risk, as well as imprecisions in the presentation of the Fourier transform on the picture screen are considered disadvantageous in the known method.

Further, methods for determining stochastic, conditioned entropies are known from W. Ebeling et al., "Entropy, Transinformation and Word Distribution of Information-Carrying Sequences," International Journal of Bifurcation and Chaos, Vol. 5, No. 1, pp. 51–61, (1995) and D. Wolpert et al., "Estimation Functions of Probability Distributions from a Finite Set of Samples," Physical Review E, Vol. 52, No. 6, pp. 6841–6854, (December 1995).

LICOX, GMS, Gesellschaft für Medizinische Sondentechnik mbH, Advanced Tissue Monitoring discloses a method with which the time curve of the local oxygen voltage of the brain (tip02) can be determined.

German OS 39 12 028 discloses a method and an arrangement for comparing wave shapes of time-variable signals.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a method in order to quickly and dependably classify a time series that contains a prescribable number of samples with the assistance of a computer.

The above object is achieved in a method conducted in a computer for classification of a time series that contains a prescribable number of samples, such as an electrical signal, by determining, in the computer, conditioned entropies for the prescribable number of samples contained in the time series, with at least one information flow for a prescribable number of future sampling times being determined in the computer from the conditioned entropies, and wherein a classification of the time series is implemented in the computer on the basis of the information flow.

In the inventive method, conditioned entropies are determined for a prescribable plurality of samples. An information flow for a prescribable plurality of future sampling points with reference whereto the time series is classified is determined from the conditioned entropies.

It is possible to speed up the classification with the method according to patent claim **5** since only a binary classification has to be implemented on the basis of the shape of the graph of the information flow. The classification of the time series into a first time series type and into a second time series type can be very simply implemented since the first time series type is classified when the graph of the information flow exhibits an approximately curved shape.

It is also advantageous to utilize the method for a time series that is made available by a measured electrocardiogram signal (ECG). A classification of the time series into an electrocardiogram signal (ECG) that describes a heart at risk with respect to sudden cardiac death as well as into an electrocardiogram signal (ECG) of a heart not at risk is possible with the determination of stochastic correlations between the samples of the time series. As a result, it is possible to recognize a risk early and to initiate a treatment against sudden cardiac death.

DESCRIPTION OF THE DRAWINGS

FIG. **1** is a flowchart describing the basic steps of the inventive method.

FIG. **2** is a flowchart showing a variation of the basic steps in FIG. **1**.

FIG. **3** is a block diagram illustrating classification of various possible time series in accordance with the invention.

FIG. **4** is a block diagram showing the basic components of a computer for implementing the inventive method.

FIG. **5** is a graph showing information flow for future values for a chaotic time series, determined in accordance with the invention, as well as a time series having non-linear correlations between its samples, as well as a time series having samples which are stochastically independent of one another.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. **1** shows that the time series that comprises a prescribable plurality of samples is measured **101** in a first step of the inventive method. The measurement ensues with a measuring instrument MG that measures both analog as well as digital signals and supplies them to a computer R (see FIG. **4**). The computer R determines **102** conditioned entropies $H(n|n-1 \ldots 1)$ for the individual samples of the time series. Various procedures are known The aforementioned Ebeling et al. and Wolpert et al. articles for the determination of the conditioned entropies $H(n|n-1 \ldots 1)$. For example, the following definition is employed in the

framework of this document for the conditioned entropies H(n|n−1 . . . 1), which, however, does not limit the possibility of employing other definitions in the framework of the inventive method:

$$H(n \mid n-1 \ldots 1) \sum_{i=1}^{k_n-1} \sum_{j=1}^{m} p(j,i) \cdot \log(p(j \mid i)) \quad (1)$$

whereby

H(n|n−1 . . . 1) respectively references the conditioned entropies,

n references a length of a sequence of samples of the time series taken into consideration

$k_n(k_n=m^n)$ references a number of different sequences of considered samples having the length n,

m references a number of values that the samples can assume,

p(j,i) references the union probabilities, and

p(j|i) references conditioned probabilities.

It is provided in the inventive method to determine the conditioned entropies H(n|n−1 . . . 1) for the prescribable number of samples that the time series comprises. However, it is likewise provided to not determine some conditioned entropies H(n|n-1 . . . 1) and to thus not take the corresponding samples into consideration. This corresponds to a reduction of the number of samples. The number of samples of the time is series taken into consideration directly reflects the precision of the inventive method with respect to the classification of the time series.

Their number of values m that the samples can assume is prescribable. The values can but need not be distributed over constant intervals.

Different possible values of samples can likewise be prescribed for different classifications. A set of prescribable values of the number m is referred to below as a partition β. The partition β thus references a set of disjunctive intervals B_i, i.e.

$$\beta = \{B_i\}_{i=1}^{m}, \bigcup_{i=1}^{m} B_i = A \wedge B_i \cap B_j = \phi \text{ for } i \neq . \quad (2)$$

i and j thereby reference a first running index and a second running index.

$$H^{\beta}(n) = -\sum_{i=1}^{k_n} p^{i,\beta}(n) \cdot \log(p^{i,\beta}(n)) \quad (3)$$

thus derives as a block entropy.

$p^{i,\beta}(n)$ thereby references the probability of the occurrence of a sample that exhibits the sample i for the partition β given a sequence of the length n.

An entropy for a prescribable number of future sampling times p is established by

$$H^{\beta}(n,p) = -\sum_{i=1}^{k_n} \sum_{j=1}^{m} p^{i,j,\beta}(n,p) \cdot \log(p^{i,j,\beta}(n,p)) \quad (4)$$

$p^{i,j,\beta}(n,p)$ thereby references the union probability of the occurrence of a sample i for the sequence having the length n and the occurrence of the sample j at a point in time that is ahead of the prescribable number of future sampling times in the framework of the partition β. With the respective pre-condition that the chronologically directly preceding sampling time is known, a conditioned entropy is referenced Hβ ((n+1)|n . . . 1).

An information flow for the prescribable number of future sampling times p for a specific partition β is formed according to the following rule:

$$I_p^{\beta} = \lim_{n \to \infty} I^{\beta}(n+p, n+n+1 \mid n \ldots 1|). \quad (6)$$

$I^{\beta}(n+p,n+1| \ldots 1)$

thereby derives from

$$I^{\beta}(n+p,n+1| \ldots 1) = H^{\beta}(n+p|n \ldots 1) + H^{\beta}(n+p|n+1 \ldots 1).$$

The partition β is defined as an infinitesimal partitioning, so that ∈=diameter (β)→0 is valid, whereby a respectively largest cell length is referenced with diameter (β).

The information flow I_p^{β} in the inventive method for a prescribable number of future sampling times p is thus formed dependent on a prescribable number of past samples n that the time series comprises.

At least one information flow I_p^{β} is determined from the conditioned entropies in a third step **103**.

A graph of the function of the information flow I_p^{β} exhibits different characteristic shapes for different time series (see FIG. **5**).

In an ideal approximation, the information flow I_p^{β} of a partition R exhibits a constant, horizontal course over the samples p for a chaotic time series CHA.

A monotonously falling, parabola-like curved function ZT1 derives qualitatively for the information flow I_p^{β} of a time series whose samples exhibit non-linear correlations. This corresponds to a first time series type ZT1. When, however, the samples exhibit no correlations whatsoever with one another, then a steep, approximately linearly falling graph of the information flow I_p^{β} for future samples is qualitatively established. This is clear on the basis of the consideration that, given non-existent correlation, future samples cannot be predicted in any way whatsoever and, thus, no information whatsoever about future samples are present. This is simply not the case for a time series whose samples exhibit non-linear correlations.

In a last step **104**, a classification is implemented on the basis of the information flow I_p^{β}. This classification can be of a different nature dependent on the area of employment.

A very simple classification that, however, proves to be an advantageous and adequate development of the method for some types of times series is comprised in a "binary" classification.

On the basis of the graph of the information flow I_p^{β} for future samples **201**, a check is performed in a check step **202** to see whether the graph is, perhaps, curved or whether is steeply drops linearly (see FIG. **2**).

When the shape of the graph exhibits a parabola-like, slightly curved, descending shape, then the time series is classified as the first time series type ZT1. Given a time series that is established by a measured cardiogram signal (ECG), this corresponds to a classification of the electrocardiogram signal (ECG) into an electrocardiogram signal (ECG) of a heart at risk with respect to sudden cardiac death.

When, however, the graph exhibits a steeply dropping, linear shape, then the time series is classified 203 into the second time series type ZT2. For the example of the elec-

46/7/51 (Item 51 from file: 350) **Links**
Derwent WPIX

0009410129 *Drawing available*
WPI Acc no: 1999-346930/199929
XRPX Acc No: N1999-259432
Pacemaker with transfer of medical data from short term to long term memory when meeting preset trigger criteria
Patent Assignee: PACESETTER INC (PACE-N)
Inventor: SLOMAN L S; WILSON R J

Patent Family (1 patents, 1 countries)

Patent Number	Kind	Date	Application Number	Kind	Date	Update	Type
US 5908392	A	19990601	US 1996596895	A	19960313	199929	B

Priority Applications (no., kind, date): US 1996596895 A 19960313

Patent Details

Patent Number	Kind	Lan	Pgs	Draw	Filing Notes
US 5908392	A	EN	0	11	

Alerting Abstract US A
NOVELTY - The pacemaker, or other implantable device, has a memory circuit with two **circular** buffers (100, 112) into which registered **medical data** are continuously loaded. When the pacemaker controller decides that a preset trigger criterion (126), e.g. an indication of an arrhythmia, has been met, the data associated with the trigger event are transferred to a long-term buffer.
DESCRIPTION - An INDEPENDENT CLAIM is also included for the following: The method of obtaining **medical data** from an implantable device.
USE - For obtaining **medical data** from **patient** with implantable cardiac device between follow-up visits to physician.
ADVANTAGE - Ensures that relevant **medical data**, and relevant data only, are stored on a long-term basis.
DESCRIPTION OF **DRAWINGS** - The **drawing** shows the two **circular** buffers for event data and waveform data as well as a list of possible trigger criteria.
100 Event buffer
112 Waveform buffer
126 List of possible criteria

Technology Focus
COMPUTING AND CONTROL - A microprocessor is used to control the device.

Title Terms /Index Terms/Additional Words: PACEMAKER; TRANSFER; MEDICAL; DATA; SHORT; TERM; LONG; MEMORY; PRESET; TRIGGER; CRITERIA

Class Codes

International Patent Classification

IPC	Class Level	Scope	Position	Status	Version Date
A61B-005/0452			Main		"Version 7"

US Classification, Issued: 600509000, 600523000

File Segment: EngPI; EPI;
DWPI Class: S05; P31
Manual Codes (EPI/S-X): **S05-A01A5A**; **S05-D01A1**

Original Publication Data by Authority

United States

Publication No. US 5908392 A (Update 199929 B)
Publication Date: 19990601
System and method for recording and storing medical data in response to a programmable trigger.
Assignee: Pacesetter, Inc., Sylmar, CA, US (PACE-N)
Inventor: Sloman, Laurence S., West Hollywood, CA, US
Wilson, Raymond J., Parker, CO, US
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Original IPC: A61B-5/0452(A)
Current IPC: A61B-5/0452(A)
Original US Class (main): 600509
Original US Class (secondary): 600523
Original Abstract: The system of the present invention records and stores, in long-term memory and in form of data snapshots, medical data acquired prior to and subsequent to an occurrence of cardiac episodes and implantable device functions defined as important by the medical practitioner. The system provides the medical practitioner with the ability to specify trigger criteria representative of important cardiac episodes and implantable device functions. The system of the present invention allows the medical practitioner to control the amount of medical data stored in the data snapshots. The system allows the medical practitioner to specify a mode of storing data snapshots when the maximum storage capacity of long-term memory has been reached. In a first mode, the system stores data snapshots in a circular buffer manner, overwriting the older data snapshots. In a second mode, the system stops storing new data snapshots after the maximum storage capacity of long-term memory has been reached.
Claim:

1. A diagnostic system for use with an implantable medical device, the system comprising:
   - sensing means for acquiring medical data from a heart;
   - first storage means for temporarily storing the medical data acquired by the sensing means;
   - a first selection means for selecting at least one trigger criteria from a plurality of trigger criteria;
   - second storage means for storing the at least one programmable trigger criterion;

- first control means for applying the at least one trigger criterion to the medical data stored in the first storage means and for determining whether the at least one trigger criteria has been met; and
- third storage means responsive to the first control means, for storing medical data acquired before and after the first control means determines that at least one trigger criterion has been met.

US005908392A

United States Patent [19]

Wilson et al.

[11] Patent Number: 5,908,392

[45] Date of Patent: Jun. 1, 1999

[54] **SYSTEM AND METHOD FOR RECORDING AND STORING MEDICAL DATA IN RESPONSE TO A PROGRAMMABLE TRIGGER**

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[73] Assignee: **Pacesetter, Inc.**, Sylmar, Calif.

[21] Appl. No.: **08/596,895**

[22] Filed: **Mar. 13, 1996**

[51] **Int. Cl.**[6] **A61B 5/0452**

[52] **U.S. Cl.** **600/509**; 600/523

[58] **Field of Search** 600/509, 513, 600/515, 518, 516, 517, 519, 521, 522, 523; 607/2, 4, 5, 6, 9, 14, 17–26, 30, 62, 32

[56] **References Cited**

U.S. PATENT DOCUMENTS

4,250,888	2/1981	Grosskopf	600/515
4,295,474	10/1981	Fischell	600/509
4,966,157	10/1990	Suzuki	600/509
5,205,283	4/1993	Olson	600/518
5,513,645	5/1996	Jacobson et al.	600/518

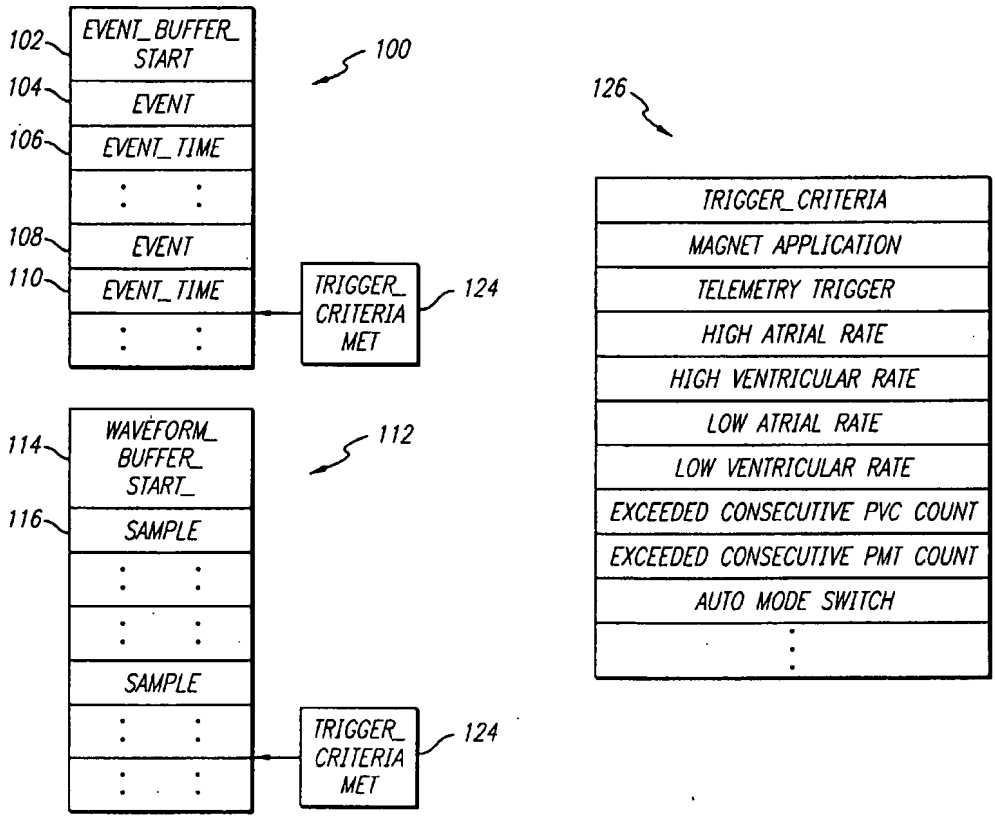
Primary Examiner—William E. Kamm

Assistant Examiner—Kennedy J. Schaetzle

[57] **ABSTRACT**

The system of the present invention records and stores, in long-term memory and in form of data snapshots, medical data acquired prior to and subsequent to an occurrence of cardiac episodes and implantable device functions defined as important by the medical practitioner. The system provides the medical practitioner with the ability to specify trigger criteria representative of important cardiac episodes and implantable device functions. The system of the present invention allows the medical practitioner to control the amount of medical data stored in the data snapshots. The system allows the medical practitioner to specify a mode of storing data snapshots when the maximum storage capacity of long-term memory has been reached. In a first mode, the system stores data snapshots in a circular buffer manner, overwriting the older data snapshots. In a second mode, the system stops storing new data snapshots after the maximum storage capacity of long-term memory has been reached.

42 Claims, 11 Drawing Sheets



pulses to the heart **12**, while another module may control the acquisition of atrial and ventricular electrical signals. In effect, each program module is a control program dedicated to a specific function or a set of functions of the pacemaker **10**.

Before describing the operation of the control program in greater detail it is helpful to define the memory structure and representative variables used for temporary and long-term storage of inter-visit medical data by the pacemaker **10** in accordance with the present invention.

An EVENT is representative of a single cardiac event occurring within a cardiac cycle. Cardiac events include, but are not limited to P-waves, R-waves, A-pulses, V-pulses, and premature ventricular contractions (PVCs). The EVENT indicates that a particular cardiac event occurred, but it does not provide the morphology of the event. Under normal circumstances, several EVENTs occur during a cardiac cycle in a particular sequence. The time relationship between sequential EVENTs is represented by an EVENT_TIME which indicates the time between an EVENT and the previous EVENT in milliseconds. A sequence of EVENTs and EVENT_TIMEs provides a relatively accurate picture of cardiac activity over one or more cardiac cycles. A cardiac episode, such as an occurrence of tachycardia may be represented by a particular sequence of EVENTs and EVENT_TIMES. Furthermore, cardiac parameters such as the natural tissue refractory period may be derived from a collection of EVENTs and EVENT_TIMEs acquired during a single cardiac cycle.

The control system **34** continuously monitors cardiac activity through the atrial sense channel amplifier **30** and the ventricular sense channel amplifier **32**. The control system **34** identifies EVENTs occurring during each cardiac cycle and also measures the EVENT_TIME between EVENTs. The EVENTs and EVENT_TIMEs are then stored in the memory circuit **52**.

A SAMPLE is representative of a single digitized sample of cardiac waveform data sampled by the control system **34** through the atrial IEGM amplifier **26** or the ventricular IEGM amplifier **28**. Examples of cardiac waveform data include, but are not limited to, atrial and ventricular intracardiac electrograms (IEGM) and raw sensor data representative of a patient's physical activity. A sequence of SAMPLEs provides a digital approximation of an analog waveform. A SAMPLING_RATE defines how many SAMPLEs of a particular waveform are acquired within a certain time. As a result, a high SAMPLING_RATE provides a better approximation of the waveform, since more SAMPLEs are available to reconstruct it.

The control system **34** continuously samples cardiac waveform data from a particular type of cardiac activity selected by the medical practitioner. The source of the selected cardiac activity is indicated by a WAVEFORM_SOURCE. The SAMPLEs representative of the sampled cardiac waveform are then stored in the memory circuit **52**. A data compression scheme could be used to reduce the memory storage requirements and increase the recording time, as is known in the art.

In FIG. **2**, two portions of the memory circuit **52** (FIG. **1**) that are used for storing inter-visit medical data are shown. The first portion is a temporary event buffer **100** which is preferably used to store EVENTs and EVENT_TIMEs. The temporary event buffer **100** is preferably a circular buffer which sequentially stores a collection of EVENTs and EVENT_TIMEs identified and measured by the control system **34** (FIG. **1**) respectively. A circular buffer is a memory management scheme which stores a certain amount of data and discards a proportional amount of old data when a certain amount of new data is received. The temporary event buffer **100** is initialized by placing a pointer at an EVENT_BUFFER_START **102** position. A pointer is a well-known program function which indicates a position in the buffer into which the control system **34** (FIG. **1**) must load the next data item, such as an EVENT or an EVENT_TIME. After the data item is loaded the pointer is moved to the next position in the buffer. When a circular buffer reaches its maximum capacity, the pointer is reset to its initial position, thus allowing the old data in the buffer to be overwritten.

As EVENTs are identified, they are placed in sequential locations in the temporary event buffer **100** with measured EVENT_TIMEs between them. For example, EVENT **104** is the first EVENT identified after the temporary event buffer **100** is initialized. EVENT_TIME **106** is the time measured between EVENT **104** and the next EVENT (not shown). When the maximum EVENT capacity for the temporary event buffer **100** is reached, the pointer is reset to the EVENT_BUFFER_START **102** (this operation is described in greater detail below in connection with FIGS. **5–11**).

The maximum capacity of the temporary event buffer **100** is defined by a programmable variable EVENT_LIMIT_2 which indicates the maximum amount of EVENTs that may be stored in the temporary event buffer **100** without overwriting the first EVENT in the buffer.

The second portion of the memory circuit **52**, is a temporary waveform buffer **112** which is preferably used to store SAMPLEs. The temporary waveform buffer **112** is a circular buffer which sequentially stores a collection of SAMPLEs representative of a particular cardiac waveform sampled by the control system **34** (FIG. **1**). The temporary waveform buffer **112** is initialized by placing a pointer at a WAVEFORM_BUFFER_START **114** position. As a cardiac waveform is sampled, SAMPLEs are placed sequentially into the temporary waveform buffer **112**. For example, a SAMPLE **116** is the first SAMPLE acquired after initialization. When the maximum SAMPLE capacity for the temporary waveform buffer **112** is reached, the pointer is reset to the WAVEFORM_BUFFER_START **114**. The maximum capacity of the temporary waveform buffer **112** is defined by a programmable variable SAMPLE_LIMIT_1 which indicates the maximum amount of SAMPLEs that may be stored in the temporary waveform buffer **112** without overwriting the first SAMPLE in the buffer.

Both the temporary event buffer **100** and the temporary waveform buffer **112** are similar to previous approaches in that they store inter-visit medical data without reference to the data's importance to the medical practitioner. In addition, the circular buffer data storage scheme used by both buffers continuously overwrites old data. As a result, important inter-visit data representative of a cardiac episode of interest to the medical practitioner may be quickly lost as the old data is overwritten. The present invention provides a solution to this problem by storing, in long-term memory, collections of EVENTs and waveform SAMPLEs that describe the patient's cardiac activity prior to and after particular cardiac episodes and occurrences of pacemaker functions which are defined as important by the medical practitioner.

A set of TRIGGER_CRITERIA is representative of individual cardiac events and sequences of cardiac events which identify cardiac episodes that the medical practitioner considers important.

TRIGGER_CRITERIA are also representative of program flags indicating occurrences of important pacemaker functions. A TRIGGER_CRITERIA being met is shown in FIG. **2** as a pointer **124** and is described in greater detail below in connection with FIG. **3**.

TRIGGER_CRITERIA are preferably selected by the medical practitioner from a list provided by the pacemaker manufacturer. A table **126** shows examples of typical TRIGGER_CRITERIA. The first TRIGGER_CRITERION, "magnet application," involves applying a magnet to the pacemaker **10** (FIG. **1**) during a follow-up visit, which enables the medical practitioner to test the TRIGGER_CRITERIA initiated recording and storage of medical data. The second criterion, "telemetry trigger," allows the medical practitioner to remotely trigger recording and storage of medical data through telemetry. For example, if the patient has a telemetry-modem interface, the medical practitioner can trigger the recording and storage of medical data via a modem from a hospital computer or the implantable device programmer.

The third and fourth criteria, "high atrial rate" and "high ventricular rate," trigger recording and storage of medical data when the intrinsic atrial or ventricular rate, respectively, exceeds a pre-determined amount (typically 90–200 bpm). Similarly, the fifth and sixth criteria, "low atrial rate" and "low ventricular rate" trigger the recording and storage of medical data when the intrinsic atrial or ventricular rate, respectively, fall below a pre-determined amount (typically 50 bpm).

The seventh criterion "exceeded consecutive premature ventricular contraction (PVC) count," serves as a trigger when the control system **34** (FIG. **1**) detects a pre-determined amount (typically 1–15) of consecutive occurrences of PVC. Similarly, the eighth criterion, "exceeded consecutive pacemaker-mediated tachycardia (PMT) count," serves as a trigger when the control system **34** (FIG. **1**) detects a pre-determined amount (typically 1–15) of consecutive occurrences of PMT. The ninth criteria, "auto mode switch," initiates the storage and recording of medical data when the control system **34** (FIG. **1**) causes the pacemaker **10** (FIG. **1**) to switch pacing modes. For example, if the pacemaker **10** (FIG. **1**) switches from an atrial-tracking mode (e.g., DDDR) to a non-atrial-tracking mode (e.g., VVIR) the recording and storage of medical data would be initiated.

The TRIGGER_CRITERIA are not limited to the above-described examples and may include two or more criteria combined using Boolean operators. For example, a TRIGGER_CRITERION may be "high atrial rate AND exceeded consecutive pacemaker-mediated tachycardia (PMT) count," in which case both of the criteria must be met before the recording and storage of medical data is initiated.

In FIG. **3**, two portions of the memory circuit **52** that are used for long-term storage of inter-visit medical data are shown. When one of the TRIGGER_CRITERIA is met, as indicated by the pointer **124** (FIG. **2**) the formation of a data snapshot by the control system **34** (FIG. **1**) is initiated. A data snapshot consists of an event snapshot and a waveform snapshot. The event snapshot is a collection of EVENTs and EVENT_TIMEs recorded prior to and subsequent to the same TRIGGER_CRITERIA being met. Similarly, the waveform snapshot is a collection of SAMPLEs recorded prior to and subsequent to one of the TRIGGER_CRITERIA being met. Each of the event and waveform snapshots also contains a TRIGGER_CRITERION_MARK which indicates the particular TRIGGER_CRITERION responsible for initiating the formation of that event and waveform snapshot. The TRIGGER_CRITERION_MARK is followed by a TIME_STAMP which indicates the time and date at which the TRIGGER_CRITERION_MARK was placed into the event and waveform snapshots. Event snapshots are stored in an event snapshot buffer **128**, while waveform snapshots are stored in a waveform snapshot buffer **140**.

The initial position of an event snapshot buffer pointer is indicated by a SNAPSHOT_BUFFER_1_START **130**, while the initial position of a waveform snapshot buffer pointer is indicated by a SNAPSHOT_BUFFER_2_START **142**.

In summary, when a TRIGGER_CRITERION is met, as indicated by the pointer **124** (FIG. **2**), the control system **34** (FIG. **1**) transfers the contents of the temporary event buffer **100** (FIG. **2**) into the event snapshot buffer **128**. A TRIGGER_CRITERION_MARK **132** and a TIME_STAMP **134** are placed into the event snapshot buffer **128**. The control system **34** (FIG. **1**) then begins recording EVENTs and EVENT_TIMEs directly into the event snapshot buffer **128**. The direct recording into the event snapshot buffer **128** is shown by an EVENT **136** and EVENT_TIME **138**. The number of EVENTs that may be recorded into the event snapshot buffer **128** before normal operation is resumed, is defined by a programmable variable EVENT_LIMIT_1. When EVENT_LIMIT_1 EVENTs have been recorded, the control system **34** (FIG. **1**) places a marker to signify the end of the event snapshot. The marker is shown as SNAPSHOT_END_1 **144**. The control system **34** (FIG. **1**) then returns to the recording EVENTs and EVENT_TIMEs into the temporary event buffer **100** (FIG. **2**).

Thus, an event snapshot consists of a collection of EVENTs and EVENT_TIMEs acquired prior to and subsequent to the TRIGGER_CRITERIA being met.

In response to the TRIGGER_CRITERION being met, the control system **34** (FIG. **1**) also transfers the contents of the temporary waveform buffer **100** (FIG. **2**) into the waveform snapshot buffer **140**. The TRIGGER_CRITERIA_MARK **132** and a TIME_STAMP **134** are placed into the waveform snapshot buffer **140**. The control system **34** (FIG. **1**) then begins recording SAMPLEs directly into the waveform snapshot buffer **140**. The number of SAMPLEs that may be recorded into the waveform snapshot buffer **140** is defined by a programmable variable SAMPLE_LIMIT_1. When SAMPLE_LIMIT_1 SAMPLEs have been recorded, the control system **34** (FIG. **1**) places the SNAPSHOT_END_2 **146** marker before returning to the normal operation of recording SAMPLEs into the temporary waveform buffer **112** (FIG. **2**). Thus, a waveform snapshot consists of a collection of SAMPLEs acquired prior to and subsequent to the TRIGGER_CRITERIA being met.

In this manner, the medical practitioner is presented with detailed information of the patient's condition before and after an important cardiac episode (e.g., an arrhythmia) or a performance of an important pacemaker function (e.g., a mode switch).

A summary of the variables and data structures discussed above in connection with FIGS. **2–3** are shown in Tables 1 and 2, respectively.

We claim:

1. A diagnostic system for use with an implantable medical device, the system comprising:

sensing means for acquiring medical data from a heart;

first storage means for temporarily storing the medical data acquired by the sensing means;

a first selection means for selecting at least one trigger criteria from a plurality of trigger criteria;

second storage means for storing the at least one programmable trigger criterion;

first control means for applying the at least one trigger criterion to the medical data stored in the first storage means and for determining whether the at least one trigger criteria has been met; and

third storage means responsive to the first control means, for storing medical data acquired before and after the first control means determines that at least one trigger criterion has been met.

2. The diagnostic system of claim 1, wherein:

the medical data comprises at least two cardiac events; and

the medical data further comprises event time data representative of the time between a current cardiac event and a previous cardiac event.

3. The diagnostic system of claim 2, wherein the medical data comprises at least one waveform.

4. The diagnostic system of claim 3, further comprising:

a physiological sensor for sensing a physiological parameter of the body; and

selection means for selecting the physiological sensor for the at least one waveform.

5. The diagnostic system of claim 3, further comprising:

second control means for defining a predetermined number of samples for the at least one waveform that may be acquired by the sensing means during a single cardiac cycle.

6. The diagnostic system of claim 3, wherein the first storage means comprises:

fourth storage means for temporarily storing the current cardiac event and also for storing the corresponding event time data; and

fifth storage means for temporarily storing the at least one waveform.

7. The diagnostic system of claim 6, further comprising:

second control means for defining a first data limit for the fourth storage means, wherein the first data limit is representative of the maximum number of the at least one cardiac events that may be stored in the fourth storage means; and

third control means for defining a second data limit for the fifth storage means, wherein the second data limit is representative of a maximum number of samples for the at least one waveform that may be stored in the fifth storage means.

8. The diagnostic system of claim 7, wherein the fourth and the fifth storage means are circular buffers, and wherein:

after the first data limit is reached the first control means overwrites the at least one cardiac event and the event time data stored in the fourth storage means with a newly acquired at least one cardiac event; and

after the second data limit is reached the first control means overwrites the at least one waveform stored in the fifth storage means with a newly acquired at least one waveform.

9. The diagnostic system of claim 8, wherein the third storage means further comprises:

sixth storage means responsive to the first control means, for storing at least one event snapshot, wherein the at least one event snapshot is representative of the at least one cardiac event and of the event time data acquired before and after the first control means determine that the at least one trigger criterion has been met; and

seventh storage means responsive to the first control means, for storing at least one waveform snapshot, wherein the at least one waveform snapshot is representative of the at least one waveform acquired before and after the first control means determine that the at least one trigger criterion has been met.

10. The diagnostic system of claim 9, further comprising:

fourth control means for disabling the sixth storage means; and

eleventh control means for disabling the seventh storage means.

11. The diagnostic system of claim 9, further comprising:

fourth control means, responsive to the first control means, for transferring the medical data stored in the fourth storage means to the sixth storage means, after the first control means determine that the at least one trigger criterion has been met;

fifth control means, responsive to the first control means, for transferring the medical data stored in the fifth storage means to the seventh storage means, after the first control means determine that the at least one trigger criterion has been met;

first recording means, responsive to the first control means, for recording into the sixth and the seventh storage means, after the first control means determine that the at least one trigger criterion has been met, data representative of the at least one trigger criterion which has been met, and data representative of the time and date during which the at least one trigger criterion has been met.

12. The diagnostic system of claim 11, further comprising:

sixth control means for defining a third data limit for the sixth storage means, wherein the third data limit is representative of the number of the at least one cardiac events that must be stored in the sixth storage means after the recording means record the data representative of the time and date during which the at least one trigger criterion has been met; and

seventh control means for defining a fourth data limit for the seventh storage means, wherein the fourth data limit is representative of maximum number of samples for the at least one waveform that must be stored in the seventh storage means after the recording means record the data representative of the time and date during which the at least one trigger criterion has been met.

13. The diagnostic system of claim 12, wherein after the recording means record data representative of the time and date during which the at least one trigger criterion has been met, the first control means:

stores the at least one cardiac event newly acquired by the sensing means, and the event time data in the sixth storage means instead of the fourth storage means until the third data limit is reached; and

stores the at least one waveform newly acquired by the sensing means in the seventh storage means instead of the fifth storage means until the fourth data limit is reached.

14. The diagnostic system of claim 13, wherein the first control means:

stores a marker representative of the end of the at least one event snapshot, in the sixth storage means when the third data limit is reached; and

stores a marker representative of the end of the at least one waveform snapshot, in the seventh storage means when the fourth data limit is reached.

15. The diagnostic system of claim 14, further comprising:

eighth control means for defining a fifth data limit representative of the maximum number of the at least one event snapshots which may be stored in the sixth storage means; and

ninth control means for defining a sixth data limit representative of the maximum number of the at least one waveform snapshots which may be stored in the seventh storage means.

16. The diagnostic system of claim 15, further comprising tenth control means for defining whether the sixth and seventh storage means operate as circular buffers, wherein:

when the sixth storage means is defined as a circular buffer, after the fifth data limit is reached the first control means overwrites the at least one event snapshot stored in the sixth storage means with a newly generated at least one event snapshot, starting with the first at least one event snapshot stored in the sixth storage means; and wherein when the sixth storage means is defined as standard buffer, after the fifth data limit is reached the first control means disables the sixth storage means so that no further event snapshots may be stored; and

when the seventh storage means is defined as a circular buffer, after the sixth data limit is reached the first control means overwrites the at least one waveform snapshot stored in the seventh storage means with a newly generated at least one waveform snapshot, starting with the first at least one waveform snapshot stored in the seventh storage means; and wherein when the seventh storage means is defined as standard buffer, after the sixth data limit is reached the first control means disables the seventh storage means so that no further waveform snapshots may be stored.

17. A diagnostic method for use with a medical device implanted in a patient, the method comprising the steps of:

(a) acquiring medical data from a heart;

(b) temporarily storing the medical data acquired during the acquiring step;

(c) selecting at least one trigger criterion from a plurality of trigger criteria;

(d) storing the at least one programmable trigger criteria;

(e) applying the at least one trigger criteria to the medical data stored during step (b);

(f) determining whether the at least one trigger criteria has been met; and

(g) storing medical data acquired before and after the determination at step (e) that at least one trigger criterion has been met.

18. The diagnostic method of claim 17, wherein the medical data comprises at least two cardiac events and event time data representative of the time between each of the at least two cardiac events.

19. The diagnostic method of claim 18, wherein the medical data comprises at least one waveform.

20. The diagnostic method of claim 19, further comprising the step of:

(h) selecting a physiological sensor as a source for the at least one waveform.

21. The diagnostic method of claim 19, further comprising the step of:

(h) defining the amount of the at least one waveform that may be acquired at step (a) during a single cardiac cycle.

22. The diagnostic method of claim 19, wherein step (b) further comprises the steps of:

(h) temporarily storing the at least one cardiac event and the event time data in a first memory location; and

(i) temporarily storing the at least one waveform in a second memory location.

23. The diagnostic method of claim 22, further comprising the steps of:

defining a first memory limit for the first memory location, wherein the first memory limit is representative of the maximum number of the at least one cardiac events that may be stored in the first memory location; and

defining a second memory limit for the second memory location, wherein the second memory limit is representative of the maximum number of samples for the at least one waveform that may be stored in the second memory location.

24. The diagnostic method of claim 23, wherein steps (h) and (i) store the medical data in circular buffers, and further comprises the steps of:

(j) overwriting the at least one cardiac event and the event time data stored in the first memory location with an at least one cardiac event newly acquired at step (a) after the first memory limit is reached; and

(k) overwriting the at least one waveform stored in the second memory location with an at least one waveform newly acquired at step (a), after the second memory limit is reached.

25. The diagnostic method of claim 24, wherein step (f) further comprises the steps of:

(l) storing at least one event snapshot in a third memory location, wherein the at least one event snapshot is representative of the at least one cardiac event and of the event time data acquired before and after the determination at step (e) that the at least one trigger criterion has been met; and

(m) storing at least one waveform snapshot in a fourth memory location, wherein the at least one waveform snapshot is representative of the at least one waveform acquired before and after the determination at step (e) that the at least one trigger criterion has been met.

26. The diagnostic method of claim 25, further comprising the steps of:

(z) disabling the third memory location; and

(aa) disabling the fourth memory location.

27. The diagnostic method of claim 25, further comprising the steps of:

(n) transferring the contents of the first memory location to the third memory location, after the determination at step (e) that the at least one trigger criterion has been met;

(o) transferring the contents of the second memory location to the fourth memory location, after the determination at step (e) that the at least one trigger criterion has been met; and

(p) recording into the third and fourth memory locations, after step (o), data representative of the at least one

trigger criterion which has been met, and data representative of the time and date during which the at least one trigger criterion has been met.

28. The diagnostic method of claim **27**, further comprising the steps of:

(q) defining a third memory limit for the third memory location, wherein the third memory limit is representative of the number of the at least one cardiac events that must be stored in the third memory location after step (p); and

(r) defining a fourth memory limit for the fourth memory location, wherein the fourth memory limit is representative of a maximum number of samples for the at least one waveform that must be stored in the fourth memory location after step (p).

29. The diagnostic method of claim **28**, further comprising the steps of:

(s) storing the at least one cardiac event newly acquired at step (a) and the event time data, in the third memory location instead of the first memory location until the third memory limit is reached; and

(t) storing the at least one waveform newly acquired at step (a) in the fourth memory location instead of the second memory location until the fourth memory limit is reached.

30. The diagnostic method of claim **29**, further comprising the steps of:

(u) storing a marker representative of the end of the at least one event snapshot, in the third memory location when the third memory limit is reached; and

(v) storing a marker representative of the end of the at least one waveform snapshot, in the fourth memory location when the fourth memory limit is reached.

31. The diagnostic method of claim **30**, further comprising the steps of:

(w) defining a fifth memory limit representative of the maximum number of the at least one event snapshots which may be stored in the third memory location; and

(x) defining a sixth memory limit representative of the maximum number of the at least one waveform snapshots which may be stored in the fourth memory location.

32. The diagnostic method of claim **31**, further comprising the step of:

(y) defining whether the third and the fourth memory locations operate as circular buffers or as standard buffers, wherein:

when the third memory location is defined as a circular buffer, after the fifth memory limit is reached, a newly generated at least one event snapshot overwrites the older at least one event snapshot stored in the third memory location; and wherein when the third memory location is defined as standard buffer, after the fifth memory limit is reached the third memory location is disabled so that no further event snapshots may be stored; and

when the fourth memory location is defined as a circular buffer, after the sixth memory limit is reached, a newly generated at least one waveform snapshot overwrites the older at least one event snapshot stored in the fourth memory location; and wherein when the fourth memory location is defined as standard buffer, after the sixth memory limit is reached, the fourth memory location is disabled so that no further waveform snapshots may be stored.

33. In an implantable cardiac device, a system for recording and storing intracardiac electrogram waveforms, comprising:

converting means for acquiring and converting intracardiac electrogram waveforms into digitized intracardiac electrogram waveforms;

storing means, coupled to the converting means, for temporarily storing a first predetermined number of the digitized intracardiac electrogram waveforms;

detecting means for detecting when a change in a patient's rhythm has occurred and for producing at least one rhythm-change signal in response thereto; and

control means, in response to the detecting means, for triggering the storing means to permanently store the first predetermined number of digitized intracardiac electrogram waveforms acquired before the at least one rhythm-change signal was detected, and a second predetermined number of digitized intracardiac electrogram waveforms after the at least one rhythm-change signal was detected.

34. The system as recited in claim **33**, further comprising:

means for programmably defining a high atrial rate threshold; and

means for detecting when the high atrial rate threshold has been exceeded and producing a high atrial rate signal in response thereto;

wherein the rhythm-change signal comprises the high atrial rate signal.

35. The system as recited in claim **33**, further comprising:

means for programmably defining a low atrial rate threshold; and

means for detecting when the low atrial rate threshold has been exceeded and producing a low atrial rate signal in response thereto;

wherein the rhythm-change signal comprises the low atrial rate signal.

36. The system as recited in claim **33**, comprising:

means for programmably defining a high ventricular rate threshold; and

means for detecting when the high ventricular rate threshold has been exceeded and producing a high ventricular rate signal in response thereto;

wherein the rhythm-change signal comprises the low atrial rate signal.

37. The system as recited in claim **33**, comprising:

means for programmably defining a low ventricular rate threshold; and

means for detecting when the low ventricular rate threshold has been exceeded and producing a low ventricular rate signal in response thereto;

wherein the rhythm-change signal comprises the low ventricular rate signal.

38. The system as recited in claim **33**, comprising:

means for programmably defining a predetermined number of consecutive premature ventricular contractions (PVCs); and

means for detecting when the predetermined number has been exceeded and producing a high PVC signal in response thereto;

wherein the rhythm-change signal comprises the high PVC signal.

39. The system as recited in claim **33**, further comprising:

means for programmably defining a predetermined number of consecutive pacemaker mediated tachycardias (PMTs); and

means for detecting when the predetermined number has been exceeded and producing a high PMT signal in response thereto;

wherein the rhythm-change signal comprises the high PMT signal.

40. In an implantable cardiac device, a system for recording and storing intracardiac electrogram waveforms, comprising:

converting means for acquiring and converting intracardiac electrogram waveforms into digitized intracardiac electrogram waveforms;

storing means, coupled to the converting means, for temporarily storing a first predetermined number of the digitized intracardiac electrogram waveforms;

programming means for selectively programming a plurality of functions into the implantable medical device;

detecting means for detecting when a change in at least one of the plurality of functions has occurred and for producing a change-in-function signal in response thereto; and

control means, in response to the detecting means, for triggering the storing means to permanently store the first predetermined number of digitized intracardiac electrogram waveforms acquired before the at least one change-in-function signal was detected, and a second predetermined number of digitized intracardiac electrogram waveforms after the at least one change-in-function signal was detected.

41. The system as recited in claim **40**, wherein:

the control means includes means for selectively operating the implantable device in one of a plurality of modes of operation, the plurality of modes of operation being selectable by the programming means;

the detecting means includes means for detecting a change in at least one of the plurality of modes of operation and for producing a change-in-mode signal in response thereto; and

the at least one change-in-function signal comprises the change-in-mode signal.

42. In an implantable cardiac device, a system for recording and storing intracardiac diagnostic data, comprising:

converting means for acquiring a plurality of intracardiac diagnostic data, including intracardiac electrogram waveforms, and converting the data into digitized signals;

storing means, coupled to the converting means, for temporarily storing a first predetermined number of the digitized signals;

detecting means for detecting when a change has occurred in one of the plurality of intracardiac diagnostic data, and for producing a trigger signal in response thereto; and

control means, in response to the detecting means, for triggering the storing means to permanently store the first predetermined number of digitized signals acquired before the trigger signal was detected, and a second predetermined number of digitized signals after the trigger signal was detected.

* * * * *

46/7/55 (Item 55 from file: 350) **Links**
Derwent WPIX

0008511362 *Drawing available*
WPI Acc no: 1998-042410/199804
XRPX Acc No: N1998-033894
Diagnostic test system with video data representation of physiological data - in which data output for specific patient comprises two dimensional graphical presentation of patient and normal individual on single report
Patent Assignee: UNIV CALIFORNIA (REGC)
Inventor: CHURCHILL B M; WAHL E F

Patent Family (2 patents, 20 countries)

Patent Number	Kind	Date	Application Number	Kind	Date	Update	Type
WO 1997046972	A1	19971211	WO 1997US9485	A	19970602	199804	B
US 6001060	A	19991214	US 199619146	P	19960604	200005	E
			US 1997865774	A	19970530		

Priority Applications (no., kind, date): US 1997865774 A 19970530; US 199619146 P 19960604

Patent Details

Patent Number	Kind	Lan	Pgs	Draw	Filing Notes	
WO 1997046972	A1	EN	24	12		
National Designated States,Original	CA IL					
Regional Designated States,Original	AT BE CH DE DK ES FI FR GB GR IE IT LU MC NL PT SE					
US 6001060	A	EN			Related to Provisional	US 199619146

Alerting Abstract WO A1
The system for patient testing includes **physiological data** which is output as a two dimensional graphical format, and may include imaging data. Colour is a dimension provided for the graphical presentation for the normal **patient data** in horizontal and vertical dimensions. Detrusor pressures are obtained.
One detrusor pressure is the difference between average data points of the bladder and rectal pressures. The other is obtained by subtracting **curve** fitted rectal and bladder pressures. The displayed data is a presentation including bladder capacity information, pressure characteristics, and data as a function of volume e.g. the bladder volume indicated.
USE - Video **data representation** of **physiological data** for e.g. video urodynamics diagnostic testing.

Title Terms /Index Terms/Additional Words: DIAGNOSE; TEST; SYSTEM; VIDEO; DATA; REPRESENT; PHYSIOLOGICAL; OUTPUT; SPECIFIC; PATIENT; COMPRISE; TWO; DIMENSION; GRAPHICAL; PRESENT; NORMAL; INDIVIDUAL; SINGLE; REPORT

Class Codes

International Patent Classification

IPC	Class Level	Scope	Position	Status	Version Date
A61B-005/00; G06T-011/00			Main		"Version 7"

US Classification, Issued: 600300000

File Segment: EngPI; EPI;
DWPI Class: S05; T01; P31
Manual Codes (EPI/S-X): **S05-D07**; T01-J06A; T01-J10C

Original Publication Data by Authority

United States

Publication No. US 6001060 A (Update 200005 E)
Publication Date: 19991214
Video data representation of physiological data.
Assignee: Regents of the University of California, Oakland, CA, US (REGC)
Inventor: Wahl, Edward F., Pacific Palisades, CA, US
Churchill, Bernard M., Pacific Palisades, CA, US
Agent: Oppenheimer, Wolff & Donnelly, LLP
Language: EN
Application: US 199619146 P 19960604 (Related to Provisional)
US 1997865774 A 19970530 (Local application)
Original IPC: A61B-5/00(A)
Current IPC: A61B-5/00(A)
Original US Class (main): 600300
Original Abstract: A system for patient diagnostic testing includes the physiological data output is in a two dimensional graphical format. Optionally, the report includes imaging data. Color is a dimension provided to the graphical presentation of normal patient data in horizontal and vertical dimensions. Detrusor pressures are obtained. One detrusor pressure is the difference between average data points of the bladder and rectal pressures. The other is obtained by subtracting curve fitted rectal and bladder pressures. The displayed data is a presentation including bladder capacity information, pressure characteristics, and data as a function of volume such that bladder volume is indicated.
Claim:

1. A method for obtaining diagnostic test data including data output of a specific patient comprising:
   - representing on a single report, at least a two dimensional graphical presentation of physiological data of a patient and at least a two dimensional graphic format of data of a normal individual relative to the specific patient;
   - processing raw data prior to representing the physiological data on the report by smoothing the raw data prior to the representation thereby to minimize noise and provide smoothed data, and subsequently processing the smoothed data to effect curve fitting;

- displaying the physiological data as a representation of urodynamic data of the patient, such representation being a presentation including bladder volume, a pressure characteristic, and the physiological data being represented as a function of bladder volume; and
- representing as an output, the urodynamic data and X-ray imaging data.

WIPO

Publication No. WO 1997046972 A1 (Update 199804 B)
Publication Date: 19971211
VIDEO DATA REPRESENTATION OF PHYSIOLOGICAL DATA
Assignee: THE REGENTS OF THE UNIVERSITY OF CALIFORNIA, US (REGC)
Inventor: CHURCHILL, BERNARD, M., US
WAHL, EDWARD, F., US
Language: EN (24 pages, 12 drawings)
Application: WO 1997US9485 A 19970602 (Local application)
Priority: US 199619146 P 19960604
Designated States: (National Original) CA IL
(Regional Original) AT BE CH DE DK ES FI FR GB GR IE IT LU MC NL PT SE
Original IPC: G06T-11/00(A)
Current IPC: G06T-11/00(A)
Original Abstract: A system for patient diagnostic testing includes the physiological data output is in a two dimensional graphical format. Optionally, the report includes imaging data. Color is a dimension provided to the graphical presentation of normal patient data in horizontal and vertical dimensions (Fig. 7). Detrusor pressures are obtained. One detrusor pressure is the difference between average data points of the bladder and rectal pressures. The other is obtained by subtracting curve fitted rectal and bladder pressures (Fig. 4). The displayed data is a presentation including bladder capacity information, pressure characteristics, and data as a function of volume such that bladder volume is indicated (Fig. 8).

US006001060A

United States Patent [19]

Churchill et al.

[11] Patent Number: 6,001,060

[45] Date of Patent: Dec. 14, 1999

[54] **VIDEO DATA REPRESENTATION OF PHYSIOLOGICAL DATA**

[75] Inventors: **Bernard M. Churchill; Edward F. Wahl**, both of Pacific Palisades, Calif.

[73] Assignee: **Regents of the University of California**, Oakland, Calif.

[21] Appl. No.: **08/865,774**

[22] Filed: **May 30, 1997**

Related U.S. Application Data

[60] Provisional application No. 60/019,146, Jun. 4, 1996.

[51] **Int. Cl.**[6] **A61B 5/00**

[52] **U.S. Cl.** **600/300**

[58] **Field of Search** 395/140, 141, 395/133; 600/300, 301, 398, 400, 440, 443, 453, 546; 128/920–924, 898, 897

[56] **References Cited**

U.S. PATENT DOCUMENTS

5,165,410	11/1992	Warne et al.	600/425
5,255,187	10/1993	Sorensen	128/923 X
5,287,273	2/1994	Kupfer et al.	600/431
5,331,548	7/1994	Rollema et al.	600/561
5,423,329	6/1995	Ergas	600/546
5,503,986	4/1996	Steers et al.	435/7.92
5,517,251	5/1996	Rector et al.	348/476
5,657,759	8/1997	Essen-Moller	600/431
5,772,584	6/1998	Davies	600/300
5,800,347	9/1998	Skates et al.	600/300
5,807,256	9/1998	Taguchi et al.	600/425

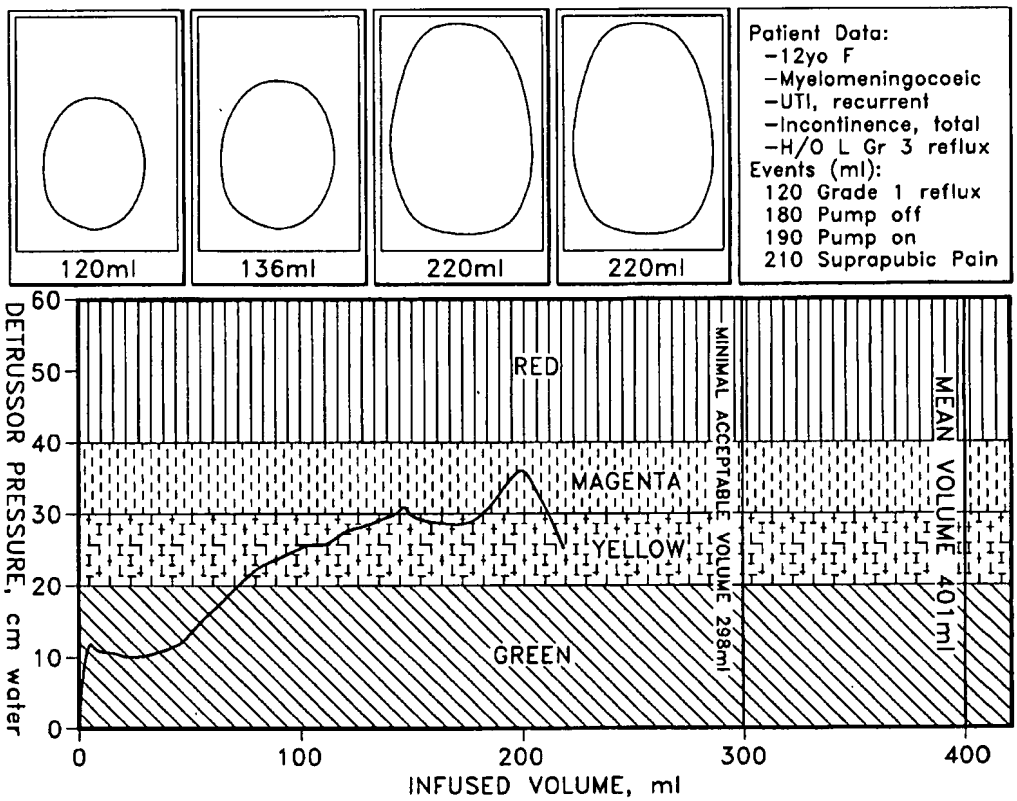
Primary Examiner—Samuel Gilbert

Attorney, Agent, or Firm—Oppenheimer, Wolff & Donnelly, LLP

[57] **ABSTRACT**

A system for patient diagnostic testing includes the physiological data output is in a two dimensional graphical format. Optionally, the report includes imaging data. Color is a dimension provided to the graphical presentation of normal patient data in horizontal and vertical dimensions. Detrusor pressures are obtained. One detrusor pressure is the difference between average data points of the bladder and rectal pressures. The other is obtained by subtracting curve fitted rectal and bladder pressures. The displayed data is a presentation including bladder capacity information, pressure characteristics, and data as a function of volume such that bladder volume is indicated.

18 Claims, 10 Drawing Sheets



graphical data is described as being in the two dimensional presentation format, it is also possible to have the data in three dimensions, namely where the data is resented in the x, y, and z axes.

The scope of the invention is to be determined by the following claims.

We claim:

1. A method for obtaining diagnostic test data including data output of a specific patient comprising:

representing on a single report, at least a two dimensional graphical presentation of physiological data of a patient and at least a two dimensional graphic format of data of a normal individual relative to the specific patient;

processing raw data prior to representing the physiological data on the report by smoothing the raw data prior to the representation thereby to minimize noise and provide smoothed data, and subsequently processing the smoothed data to effect curve fitting;

displaying the physiological data as a representation of urodynamic data of the patient, such representation being a presentation including bladder volume, a pressure characteristic, and the physiological data being represented as a function of bladder volume; and

representing as an output, the urodynamic data and X-ray imaging data.

2. A method as claimed in claim 1 including the incorporation of zones as a dimension to the graphical presentation of the physiological data of the normal individual, such normal data being in horizontal and vertical dimensions.

3. A method as claimed in claim 2 wherein the zones are colors, the colors being selectively green, yellow and red.

4. A method as claimed in claim 2 including filtering the raw data, such that when operating under at least one of the conditions that, when a rate of rise of pressure exceeds a pre-set value the raw data obtained under such conditions is discarded, or when a pressure exceeds an average pressure that had been maintained over a recent time period by more than a pre-set amount, the raw data obtained under such conditions is discarded.

5. A method as claimed in claim 2 including obtaining a detrusor pressure, such detrusor pressure being obtained by first smoothing a bladder pressure data and a rectal pressure data obtained from a measurement of pressure in the abdomen and then subsequently performing a subtraction of such bladder pressure and rectal pressure to obtain the detrusor pressure.

6. A method as claimed in claim 5 wherein the graphical presentation contains two detrusor pressures, one detrusor pressure being the difference between a time spaced average data points of the bladder and rectal pressures and the other pressure being obtained by subtracting curve fitted rectal and bladder pressures.

7. A method as claimed in claim 1 including obtaining the raw data through analog measurement means, an analog to digital data conversion means for converting the raw data to a digital input, a software program for reading the digital input, means for sampling the converted raw data for minimizing artifacts in the converted raw data that are substantially non physiological while retaining the physiological data.

8. A method as claimed in claim 1 including providing the colors of green, yellow and red as background on which the physiological data is displayed, and the presentation includes bladder capacity information as vertical lines, and pressure as horizontal colored areas.

9. A method as claimed in claim 1 including analyzing in real time the collected raw data which has been processed, and analyzing the processed data in relation to data obtained after obtaining the collected raw data, and including taking the collected raw data from the patient and calculating characteristics for displaying the physiological data.

10. A method as claimed in claim 1 including directing a catheter into a bladder, including filling the bladder with fluid, and measuring the bladder pressure, and locating in the abdomen a sensor for measuring pressure in the abdomen in the area outside the bladder.

11. A method as claimed in claim 1 including rendering the representation of urodynamic data as an output display reported in relation to color, the color being selectively representative of physiological significant data.

12. A method as claimed in claim 1 wherein the diagnostic test data output of a specific patient is related relative to representative data of a normal individual.

13. A method for obtaining diagnostic test data including data output for a patient comprising:

representing on a single report, a graphical presentation of physiological data of the patient and imaging data of the patient;

processing raw data prior to representing the physiological data on the report by smoothing the raw data prior to the representation thereby to minimize noise and provide smoothed data, and subsequently processing the smoothed data to effect curve fitting;

displaying the physiological data as a representation of urodynamic data of the patient, such representation being a presentation including bladder volume, a pressure characteristic, and the physiological data being represented as a function of bladder volume; and

representing as an output, the urodynamic data and X-ray imaging data.

14. A method for obtaining urodynamics diagnostic test data of a patient comprising representing the production of a graphical presentation report of physiological data of a specific patient, and imaging data of internal anatomical features of the patient, including incorporating zones as a dimension to the graphical presentation of data of a normal individual relative to the physiological data of specific patient data, such normal data being portrayed in horizontal and vertical dimensions;

analyzing in real time the physiological data and further analyzing the collected data in relation to data obtained after obtaining the physiological data;

processing and presenting the, including taking the patient data and calculating the characteristics for the display; and

displaying the physiological data as a presentation, such presentation including bladder capacity information, and a pressure characteristic, and additionally displaying the imaging data.

15. A method as claimed in claim 14 wherein the zones are colors, the colors being selectively green, yellow and red.

16. A method as claimed in claim 15 including providing the colors of green, yellow and red as background on which the physiological data is displayed, and the presentation includes bladder capacity information as vertical lines, and pressure as horizontal lines.

17. A method as claimed in claim 14 wherein the diagnostic test data output of a specific patient is related relative to representative data of a normal individual.

18. A method for obtaining urodynamic diagnostic test data comprising representing data output of a patient as a graphical presentation report of the test data of the patient and including incorporating different discrete color zones as a background dimension to the graphical presentation of data of a relatively normal individual in horizontal and vertical dimensions, obtaining detrusor pressures, one detrusor pressure being the difference between data points of the bladder and rectal pressures and the other being obtained by subtracting rectal and bladder pressures, including displaying as the data, bladder capacity information, pressure characteristics, and data as a function of bladder volume; and

relating data output of a specific patient relative to urodynamic data of a normal individual.

* * * * *

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Set     Items   Description
S1    1174340   S ELECTROPHYSIOLOG? OR HEMODYNAMIC? OR HAEMODYNAMIC?
S2     819272   S (BODY OR BIOLOGIC? OR VITAL OR PHYSIOLOGIC? OR MEDICAL? OR PATIENT? OR
OUTPATIENT? OR INPATIENT?)(2N)(SIGN? ? OR SIGNAL? OR OUTPUT? OR DATA? OR READING? OR
REPORT? OR INPUT?)
S3       2072   S VPC(3N)(VENTRICUL? OR PREMATUR? OR CONTRACTION?) OR
VENTRICUL?()PREMATUR?()CONTRACTION?
S4    2427446   S HR(3N)(HEART OR RATE?) OR HEART()RATE? OR PULSE? OR (QT OR QWAVE? OR
TWAVE? OR Q()WAVE? OR T()WAVE?)()INTERVAL?
S5     610652   S SPO2()VALUE? OR OXYGEN()(SATURAT? OR VALUE? OR LEVEL? OR PARAMETER?) OR
BLOOD()(GAS OR GASES OR GASSES) OR ELECTROCARD?
S6    1306588   S HRV(3N)(HEART OR RATE OR VARIABILITY) OR SYSTOLIC? OR DIASTOL? OR (BLOOD
OR ARTER?)()PRESSUR?
S7     104996   S WAVEFORM()(INDEX? OR INDICE?) OR OXIMET? OR PLESTHYM? OR (BREATH? OR
RESPIRAT?)()RATE?
S8    5423513   S S1:S7
S9      34541   S (DISPLAY? OR GRAPHIC? OR VISUAL?)()(OBJECT? OR SIGNAL? OR INDICATOR?) OR
ICON? ?
S10   2649098   S INDICATOR? OR GRAPH? ? OR CHART? ? OR DIAGRAM?
S11   1396367   S INSIGNIA OR REPRESENTATION? ? OR PICTORIAL OR DRAWING? ?
S12   1077344   S (PERSONAL? OR CUSTOM? OR TAILOR? OR ONLINE)(2N)(ID OR IDENTIFIER? OR
LOGO? OR SYMBOL? OR SIGNIFIER? OR OBJECT? OR PERSONA?)
S13     48873   S AVATAR? OR EMOTICON? OR FIGURINE? OR SMALL(2N)(IMAGE? OR GRAPHIC? OR
BITMAP?) OR METAPHOR?
S14     33547   S (SCREEN? OR ELECTRONIC?)(2N)(REPRESENTATION? OR PICTUR? OR PICTOR? OR
IMAGE? OR SYMBOL? OR FIGURE?) OR SPRITE?
S15    250755   S GRAPHICOBJECT? OR WIZARD? OR PIXIE? OR JINI? OR GENIE? OR TUTORIAL?
S16    176815   S (VIRTUAL? OR ANTHROPOMORPH? OR CARTOON? OR TOON? ? OR ANIMAT? OR
GRAPHIC? OR VISUAL?)(3N)(CHARACTER? OR CREATUR? OR ENTIT? OR ASSISTANT? OR SYMBOL? OR
REPRESENTATION? OR AGENT? OR INTERFACE?)
S17    232874   S S8 AND S9:S16
S18     30969   S CIRCL? OR CIRCUL? OR CURVE? OR CURVAT? OR INCURV? OR PIESHAP? OR
PIE(2N)SHAPE? OR PIECHART? OR PIE()CHART?
S19      1141   S CONCAV? OR CONVEX? OR ROUND? OR (DISH OR DISK OR DISC OR PLATE? OR
SAUCER?)()SHAPE?
S20      1633   S ARC OR ARCED OR ARCH??? OR ARCUAT? OR ARCIFORM? OR SEMICIRC?
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DISCSHAP? OR DISKSHAP? OR DISHSHAP?
S22     14334   S HISTORY OR HISTORIE? OR ARCHIV? OR CHRONOLOG? OR PAST OR TIMESTAMP? OR
TIMEDAT?
S23      4078   S TIME()(STAMP? OR DATE? OR SERIE?) OR YESTER? OR BASAL
S24     50806   S PRIOR? OR BEFORE? OR EARLIER OR PREVIOUS
PRECEED??? OR AHEAD
S25     43600   S EARLY OR PRE OR LAST OR ANTECEDENT OR FI
S26     69543   S BACKHISTORY OR BACKSTORY OR BACKGROUND O
RECORD? ? OR CHRONICLE? ? OR ANNALS
S27      9452   S CASEHISTOR? OR REGRESSI? OR HERITAG? OR
S28     21249   S S17 AND S18:S21 AND S22:S27
S29      1565   S S28 AND S18:S21(7N)S9:S16
S30       399   S S29 AND (S9:S16 OR S18:S21)(7N)S22:S27
S31       166   S S30 AND S1:S7(7N)(S9:S16 OR S18:S21 OR S
S32       102   S S30 AND S9:S16(5N)S22:S27 AND S18:S21(5N
S33       194   S S30 AND (S1:S7 OR S9:S16 OR S18:S21 OR S
S34       287   S S31:S33
S35       222   S S34 AND PY=1970:2003
S36       228   S S34 NOT PY=2004:2007
S37       228   S S35:S36
S38       167   RD  (unique items)
 ; show files
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NONPAT LIT

BIBLIO

FILES

[File 2] **INSPEC** 1898-2007/Jan W2

[File 5] **Biosis Previews(R)** 1969-2007/Jan W2

[File 6] **NTIS** 1964-2007/Jan W2

[File 8] **Ei Compendex(R)** 1884-2007/Jan W1

**File 8: The file has been reprocessed and accession numbers have changed. See HELP NEWS988 for details.*

[File 23] **CSA Technology Research Database** 1963-2006/Dec

[File 34] **SciSearch(R) Cited Ref Sci** 1990-2007/Jan W2

[File 35] **Dissertation Abs Online** 1861-2006/Nov

[File 45] **EMCare** 2007/Jan W2

[File 56] **Computer and Information Systems Abstracts** 1966-2006/Dec

[File 65] **Inside Conferences** 1993-2007/Jan 19

[File 73] **EMBASE** 1974-2007/Jan 17

**File 73: Elsevier will not provide the daily update to Embase . on January 18. Tomorrow's update will contain both days.*

[File 94] **JICST-EPlus** 1985-2007/Jan W3

**File 94: UD200609W2 is the last update for 2006. UD200701W1 is the first update for 2007. The file is complete and up to date.*

[File 95] **TEME-Technology & Management** 1989-2007/Jan W2

[File 99] **Wilson Appl. Sci & Tech Abs** 1983-2007/Dec

[File 144] **Pascal** 1973-2007/Jan W2

[File 155] **MEDLINE(R)** 1950-2006/Dec 16

**File 155: MEDLINE has resumed updating with UD20061209. Please see HELP NEWS 154 for details.*

[File 239] **Mathsci** 1940-2007/Feb

[File 256] **TecInfoSource** 82-2007/Aug

[File 431] **MediConf: Medical Con. & Events** 1998-2004/Oct B2

**File 431: The file no longer updates.*

[File 434] **SciSearch(R) Cited Ref Sci** 1974-1989/Dec

38/5,K/69 (Item 11 from file: 34) Links
SciSearch(R) Cited Ref Sci

00994984 **Genuine Article#:** FM432 **Number of References:** 16

IS A PICTURE WORTH A 1000 MEDICAL WORDS - A RANDOMIZED TRIAL OF REPORTING FORMATS FOR MEDICAL-RESEARCH DATA

Author: ELTING LS; BODEY GP
Corporate Source: UNIV TEXAS,MD ANDERSON CANC CTR,DEPT MED SPECIALITIES,BOX 47/HOUSTON//TX/77030
Journal: METHODS OF INFORMATION IN MEDICINE , **1991** , V 30 , N2 , P 145-150
Language: ENGLISH **Document Type:** ARTICLE
Geographic Location: USA
Subfile: SciSearch; CC CLIN--Current Contents, Clinical Medicine
Journal Subject Category: MEDICINE, MISCELLANEOUS; COMPUTER APPLICATIONS & CYBERNETICS
Abstract: Monitoring data that vary over time is an essential component of medical practice. This is doubly true in clinical trials in which the overall safety and efficacy of investigational treatments in populations must be monitored in addition to the status of the individual patients who receive them. We report the results of a randomized trial of four reporting methods for time-dependent information derived from clinical trials; narrative text, table, **pie chart** and **icon**. Multivariate analysis of variance with a repeated measures design was used to analyze the efficiency of subjects' (physicians, research nurses and laboratory personnel) assimilation of information. **Icons** were found to be superior to the other reporting formats tested in both speed ($p < 0.0001$) and accuracy ($p = 0.02$). The differences were most pronounced in subjects' **first** exposure to the data, suggesting that **icons** reduce the time needed for training. We conclude that **icons** are a valuable method for presentation of time-dependent information in medical settings.
Descriptors--Author Keywords: MEDICAL MONITORING; CLINICAL TRIALS; **ICON**; GRAPHICAL DISPLAYS
Identifiers-- KeyWords Plus: INTERFACE
Cited References:

BEWLEY WL, 1983, P72, P HUMAN FACTORS COMP
CHERNOFF H, 1983, V69, P361, J AM STAT ASSOC
COLE BL, 1988, V8, P198, OPHTHAL PHYSL OPT
COLE WG, 1990, P425, 14TH P S COMP APPL M
DEZEGHERGEETS I, 1988, V5, P8, MD COMPUT
ELTING L, 1988, P459, 12TH P S COMP APPL M
GITTINS D, 1986, V54, P519, INT J MAN MACH STUD
GITTINS DT, 1984, V21, P451, INT J MAN MACH STUD
GUASTELLO SJ, 1989, V31, P99, INT J MAN MACH STUD
HEMENWAY K, 1982, P20, P HUMAN FACTORS COMP
LEGGE GE, 1989, V46, P365, PERCEPT PSYCHOPHYS
MOSES F, 1980, P229, P NATO C VISUAL PRES
MURCH G, 1984, P49, IEEE COMPUTER GR NOV
SCHWARTZ DR, 1985, V27, P433, HUM FACTORS
SPURLOCK M, 1987, P1, P AM PETROLEUM I OPE
TULLIS TS, 1981, V23, P541, HUM FACTORS

IS A PICTURE WORTH A 1000 MEDICAL WORDS - A RANDOMIZED TRIAL OF REPORTING FORMATS FOR MEDICAL-RESEARCH DATA

, 1991

Abstract: ...of four reporting methods for time-dependent information derived from clinical trials; narrative text, table, pie chart and icon. Multivariate analysis of variance with a repeated measures design was used to analyze the efficiency of subjects' (physicians, research nurses and laboratory personnel) assimilation of information. Icons were found to be superior to the other reporting formats tested in both speed ($p < 0.0001$) and accuracy ($p = 0.02$). The differences were most pronounced in subjects' first exposure to the data, suggesting that icons reduce the time needed for training. We conclude that icons are a valuable method for presentation of time-dependent information in medical settings.

38/5,K/44 (Item 4 from file: 8) **Links**
Ei Compendex(R)

07477867 **E.I. No:** EIP96083291419
Title: Noninvasive elasticity characterization of carotid artery using high-frame-rate echography and sphygmomanometer

Author: Masuda, K.; Ishihara, K.; Nagakura, T.; Tsuda, T.; Furukawa, T.; Kumagai, S.; Kodama, S.
Corporate Source: Osaka Univ, Yamadaoka, Jpn
Conference Title: Proceedings of the 1st 1995 Regional Conference IEEE Engineering in Medicine & Biology Society and 14th Conference of the Biomedical Engineering Society of India
Conference Location: New Delhi, India **Conference Date:** 19950215-19950218
E.I. Conference No.: 45145
Source: Proc 1 1995 Reg Conf IEEE Eng Med Biol Soc 14 Conf Biomed Eng Soc India 1995. IEEE,95TH8089. p 4.69-4.70
Publication Year: 1995
Language: English
Document Type: CA; (Conference Article) **Treatment:** A; (Applications); T; (Theoretical); X; (Experimental)
Journal Announcement: 9610W3
Abstract: We visualized elasticity of common carotid artery noninvasively. Elastic index is calculated from expanding velocity of artery and continuous **blood pressure**. Expanding velocity is given from processing **time series** echograms recorded by a high-frame-rate echography. **Blood pressure** is given from a noninvasive sphygmomanometer using a cuff wound up to arm. The transition of velocity is related to **blood pressure**. **Drawing** pressure-velocity **curve**, elasticity of carotid artery can be classified from shape of the **curve**. In a young elastic artery, **curve** reveals similar to **circle**. In proportion to older artery, shape of **curve** becomes to be flattened out. From enclosed area of the **curve**, elasticity of artery can be estimated. (Author abstract) 3 Refs.
Descriptors: *Blood vessels; Elasticity; Visualization; Echocardiography; Biomedical equipment; Noninvasive medical procedures; Velocity; **Hemodynamics**; Calculations; Medical imaging
Identifiers: Noninvasive elasticity characterization; Carotid artery; High frame rate echography; Sphygmomanometer; **Time series** echograms; **Drawing** pressure velocity **curve**; Young elastic artery
Classification Codes:
461.2 (Biological Materials); 931.2 (Physical Properties of Gases, Liquids & Solids); 461.6 (Medicine); 462.1 (Biomedical Equipment, General); 461.1 (Biomedical Engineering)
461 (Biotechnology); 931 (Applied Physics); 462 (Medical Engineering & Equipment); 921 (Applied Mathematics)
46 (BIOENGINEERING); 93 (ENGINEERING PHYSICS); 92 (ENGINEERING MATHEMATICS)
Abstract: ...common carotid artery noninvasively. Elastic index is calculated from expanding velocity of artery and continuous **blood pressure**. Expanding velocity is given from processing **time series** echograms recorded by a high-frame-rate echography. **Blood pressure** is given from a noninvasive sphygmomanometer using a cuff wound up to arm. The transition of velocity is related to **blood pressure**. **Drawing** pressure-velocity **curve**, elasticity of carotid artery can be classified from shape of the **curve**. In a young elastic artery, **curve** reveals similar to **circle**. In proportion to older artery, shape of **curve** becomes to be flattened out. From enclosed area of the **curve**, elasticity of artery can be estimated. (Author abstract) 3 Refs.
Descriptors: *Blood vessels; Elasticity; Visualization; Echocardiography; Biomedical equipment; Noninvasive medical procedures; Velocity; **Hemodynamics**; Calculations; Medical imaging
Identifiers: Noninvasive elasticity characterization; Carotid artery; High frame rate echography; Sphygmomanometer; **Time series** echograms; **Drawing** pressure velocity **curve**; Young elastic artery

38/5,K/41 (Item 1 from file: 8) **Links**
Fulltext available through: ScienceDirect (Elsevier) USPTO Full Text Retrieval Options SCIENCEDIRECT
Ei Compendex(R)

08485356 **E.I. No:** EIP00025056102
Title: In vitro flow quantification with contrast power Doppler imaging

Author: Ugolini, Patricia; Delouche, Annie; Herment, Alain; Diebold, Benoit
Corporate Source: Hopital Broussais, Paris, Fr
Source: Ultrasound in Medicine and Biology v 26 n 1 2000. p 113-120
Publication Year: 2000
CODEN: USMBA3 **ISSN:** 0301-5629
Language: English
Document Type: JA; (Journal Article) **Treatment:** T; (Theoretical); X; (Experimental)
Journal Announcement: 0004W2
Abstract: To evaluate the effectiveness of contrast harmonic (power Doppler imaging) as an ultrasonic modality to quantify flow, an in vitro model of perfusion was studied using Optison**T**M, a second-generation ultrasound (US) contrast agent. The in vitro model was made of two dialysis cartridges placed parallel and allowed absolute and relative flow quantification on both tube (entry lines) and tissue (cartridges) simulations. Video intensity **curves** were generated using intermittent harmonic power Doppler imaging after bolus injection of contrast. Correlation between flow and different parameters extracted from time-intensity **curves** and **previously** defined as **indicators** of flow was established for both tissue and entry lines, for flow rates ranging from 0 to 400 mL/min.
Single-compartment equations were also tested on the model. A good correlation for the tissue model was observed between absolute flow and onset time (O), time to maximal enhancement (TME), peak intensity (P), area under the **curve** (AUC), and maximal ascending slope (S) parameters, with a r equals 0.94, 0.94, 0.91, 0.92 and 0.92, respectively. The correlation for O, TME, P and AUC parameters was r equals 0.86, 0.90, 0.78 and 0.82, respectively for entry lines. The correlation for tissue model and entry line was slightly improved when comparing flow ratios with peak ratios (P1/P2) and slope ratios (S1/S2) (r equals 0.95 and 0.94). Flow calculation using the gradient-relationship method also showed a good correlation (r equals 0.88) with the experimental flow. The results obtained indicated that absolute and relative quantification of flow using PDI is feasible in tube and tissue models. Several clinical applications, namely in myocardial, hepatic and renal artery studies, could be derived from these results. (Author abstract) 15 Refs.
Descriptors: *Ultrasonic imaging; Medical imaging; Doppler effect; **Hemodynamics**; Correlation methods; Contrast media; Physiological models
Identifiers: Power Doppler imaging
Classification Codes:
753.3 (Ultrasonic Applications); 461.1 (Biomedical Engineering); 751.1 (Acoustic Waves); 922.2 (Mathematical Statistics)
753 (Sound Technology & Ultrasonics); 461 (Biotechnology); 751 (Acoustics); 922 (Statistical Methods); 803 (Chemical Agents & Basic Industrial Chemicals)
75 (ACOUSTICAL TECHNOLOGY); 46 (BIOENGINEERING); 92 (ENGINEERING MATHEMATICS); 80 (CHEMICAL ENGINEERING)
Abstract: ...and relative flow quantification on both tube (entry lines) and tissue (cartridges) simulations. Video intensity **curves** were generated using intermittent harmonic power Doppler imaging after bolus injection of contrast. Correlation between flow and different parameters extracted from time-intensity **curves** and **previously** defined as **indicators** of flow was established for both tissue and entry lines, for flow rates ranging from... ...and onset time (O), time to maximal enhancement (TME), peak intensity (P), area under the **curve** (AUC), and maximal

ascending slope (S) parameters, with a r equals 0.94, 0.94...
Descriptors: *Ultrasonic imaging; Medical imaging; Doppler effect; **Hemodynamics**; Correlation methods; Contrast media; Physiological models

38/5,K/70 (Item 1 from file: 35) **Links**
Dissertation Abs Online

01874175 ORDER NO: AADAA-I3044146
Denoising via empirical Bayesian pursuit

Author: Kramer, Michael L.
Degree: Ph.D.
Year: 2002
Corporate Source/Institution: University of Illinois at Urbana-Champaign (0090)
Adviser: Douglas L. Jones
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Descriptors: ENGINEERING, ELECTRONICS AND ELECTRICAL
Descriptor Codes: 0544
ISBN: 0-493-58004-2

Linear time-frequency and time-scale **representations** (e.g., the discrete Gabor **representation** or the discrete wavelet **representation**) provide useful tools for analyzing a variety of time-varying sampled **signals** including speech, **medical** and geophysical **data**, communications signals, and images. These **representations** often yield overdetermined signal expansions; for example, adaptive **representations** such as those arising from best window or best basis methods frequently compute highly overdetermined **representations prior** to selecting a subset of coefficients for the analysis **representation**. This dissertation addresses novel performance metrics and methods for blind signal recovery, or denoising, that employ all of the overdetermined **representation** coefficients. The introduction of <italic>L</italic>-unitary frames facilitates the analysis, for which many nondecimated, linear, time-frequency and time-scale **representations** qualify, as do mergers of multiple <italic>L</italic>-unitary frames. Worst-case bounds are derived on squared estimation error when denoising via hard-thresholding followed by efficient averaging-based synthesis in bounded noise environments; similar bounds guarantee minimum signal-to-interference ratios for spread-spectrum interference suppression. After this, the potential of denoising in a signal-adapted frame obtained via an eigendecomposition of the threshold-then-average denoising filter is considered, including proposing alternative eigendomain weightings as well as the derivation of lower bounds on signal concentration in the new eigenframe **representation**. Following the eigenanalysis of the threshold-then-average denoising filter, a hidden Gaussian mixture (GM) signal model is considered. Monte Carlo Markov-chain methods are developed for converging to optimal model parameter estimates, which are then used to generate a signal-dependent Wiener filter for denoising. Finally, the solution to the latent GM model problem is briefly related to traditional methods such as complexity-based signal reconstruction, projection onto (signal-adapted) **convex** subsets, and pursuit-based **representation** methods.
Year: 2002

Linear time-frequency and time-scale **representations** (e.g., the discrete Gabor **representation** or the discrete wavelet **representation**) provide useful tools for analyzing a variety of time-varying sampled **signals** including speech, **medical** and geophysical **data**, communications signals, and images. These **representations** often yield overdetermined signal expansions; for example, adaptive **representations** such as those arising from best window or best basis methods frequently compute highly overdetermined **representations prior** to selecting a subset of coefficients for the analysis **representation**. This dissertation addresses novel performance metrics and methods for blind signal recovery, or denoising, that employ all of the overdetermined **representation** coefficients. The introduction of <italic>L</italic>-unitary frames facilitates the analysis, for which many nondecimated, linear,

time-frequency and time-scale **representations** qualify, as do mergers of multiple <italic>L</italic>-unitary frames. Worst-case bounds are... ...as well as the derivation of lower bounds on signal concentration in the new eigenframe **representation**. Following the eigenanalysis of the threshold-then-average denoising filter, a hidden Gaussian mixture (GM... ...briefly related to traditional methods such as complexity-based signal reconstruction, projection onto (signal-adapted) **convex** subsets, and pursuit-based **representation** methods.